Board Approval Date: 8/23/22
Course Title: Engineering Design 2
Course Description: Engineering Design 2 builds upon the skills introduced in the Engineering Design 1 course to solve higher level engineering design problems. Students utilize important science and mathematics concepts, common to most engineering disciplines, to develop more complex CAD drawings. Analyzing real life case studies allows students to enhance their basic skills for solving open-ended problems using the design process consisting of: documentation, material manipulation, internet research and mechanical drawing. Students in this class compete in problem solving and engineering design competitions.

Course Sequence & Pacing			
Estimated Number of Blocks	**Marking Period 1**	**Estimated Number of Blocks**	**Marking Period 3**
8	Unit 1: Computer Aided Design	9	Unit 6: Buoyancy
5	Unit 2: Engineering Equipment	13	Unit 7: Hydraulic & Pneumatics
8	Unit 3: CO2 Dragster		
Estimated Number of Blocks	**Marking Period 2**	**Estimated Number of Blocks**	**Marking Period 4**
11	Unit 4: Computer System	11	Unit 8: Projectile Motion
11	Unit 5: Aerodynamics	11	Unit 9: Drones & Photogrammetry

Stage 1 Desired Results

Unit Title #: Unit 1: Computer Aided Design

Unit Summary: The Computer Aided Design unit will build on what was learned in Engineering Design 1 starting with more complex 3D geometries, the creation of multi-part assemblies, and the creation of various types of engineering drawings that are used in industry.

Unit Learning Targets

NJSLS Standards:

• 8.2.12.ED.1: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
• 8.2.12.ED.2: Create scaled engineering drawings for a new product or system and make modification to increase optimization based on feedback
• 8.2.12.ED.3: Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis.
• 8.2.12.ED.5: Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).
• 8.2.12.ED.6: Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)***:**

• 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas
• 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
• 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
• 9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8)
• 9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).

Computer Science & Design Thinking *(CS & DT)***:**

See NJSLS section.

Interdisciplinary Connections ELA, Math, VPA, etc

RI.CR.9–10.1
Cite strong and thorough textual evidence and make relevant connections to support analysis of what the text says explicitly as well as inferences drawn from the text.

RI.CI.9–10.2
Determine one or more central ideas of an informational text and analyze how it is developed and refined over the course of the text, including how it emerges and is shaped by specific details; provide an objective summary of the text.

RI.MF.9–10.6
Analyze, integrate, and evaluate multiple interpretations (e.g., charts, graphs, diagrams, videos) of a single text or text/s presented in different formats (visually, quantitatively) as well as in words in order to address a question or solve a problem.

SL.9–10.4
Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

Unit Essential Questions: (*Open-ended, Higher-order, Thought Provoking)*	**Unit Enduring Understandings:** (*Statements that connect to EQ's summarizing important ideas and core processes that are central to a discipline and have lasting value beyond the classroom)*
What are the applications of 2D and 3D CAD? How has rapid prototyping influenced the design of products? What is the future of CAD and rapid prototyping? What are the limitations of CAD systems? How can CAD systems be used to identify potential issues with the design of a product? How is engineering drawing interrelated with CAD systems? How can CAD systems be used to test potential designs?	The use of computer aided design (CAD) has revolutionized the design of products. There are different types of CAD systems, each with different uses and purposes. There are multiple career paths, across a wide range of disciplines, that utilize CAD systems. Rapid prototyping allows for an increased iterative process in the design of products.
Students will know: *(Content, Noun)*	**Students will be able to:** *(Verb Bloom's Taxonomy)*
The types of lines used in engineering drawings.	Create 2D engineering drawings using a CAD system.

3D objects can be created in a variety of ways. Engineers utilize 3D modeling software to increase productivity and decrease error. Vocabulary: Ribbon, Point, Object snap, End point, Mid Point, Tangent, Extrude, Rotate, Loft, Layers, Constraint, Crosshairs, Extrude, Loft, Revolve, Fillet, Chamfer, Rapid prototyping, 3D printer,Exploded Assembly, Bill of Material, Assembly, Mate, Join, Offset	Create digital 3D objects using a CAD system. Differentiate between additive and subtractive solid modeling methods. Design products using CAD. Apply the properties of geometric shapes in the creation of engineering drawings. Create an assembly of parts using a 3D CAD system. Design a product using the engineering design process on a 3D CAD system to be 3D printed. Generate CAD multi-view technical drawings, including orthographic projections and pictorial views as necessary. Create relationships between parts of an assembly. Apply vocabulary in student reading, writing, speaking and listening.

Stage 2 Assessment Evidence

Summative Assessments:

Creation of muti-view and pictorial engineering drawings of 3D CAD parts
Vocabulary quizzes
Linetype quiz
Dial Caliper quiz
Project presentation or report

Formative Assessments:

Creation of engineering drawings.
Creation of digital objects using a 3D CAD system.

Designing a product using a 3D CAD system.
Presentation of designed parts.
Assembly of parts in 3D CAD system.

Common Benchmark Assessments:
Creation of muti-view and pictorial engineering drawings of 3D CAD parts

Alternative Assessments:
Multimedia presentation on design project

Stage 3 Learning Plan

Standard	***Skill***	***Learning Activities & Differentiation*** *(Asian American & Pacific Islanders, LGBTQ and People with Disabilites, Diversity, Equity & Inclusion [DEI],)*	***Timeframe*** *(Blocks)*
8.2.12.ED.5 9.4.12.CI.1 9.4.12.CT.1 9.4.12.IML.3	Explain how the proper use of line types, 2D drawing formats, proper sketching techniques and the use of dial calipers will increase an engineer's productivity and reduce errors.	• Review past knowledge of line types • Review past knowledge of sketching and 2D drawings • Discuss the use of dial calipers • Creation of hand sketches	1
8.2.12.ED.1 8.2.12.ED.3	Build on past knowledge of 3D modeling and discuss different ways of creating a variety of objects. Explain how the variety of hole types are used and created in 3D modeling.	• Review past knowledge of 3D modeling • Creation of 3D Modeling with advanced features • Creation of various hole types	3

		• Creation of 3D models from measuring, sketching, and detailing hand drawings	
8.2.12.ED.1 8.2.12.ED.2 8.2.12.ED.3 8.2.12.ED.5 9.4.12.CI.1 9.4.12.CT.1	Explain how a proper engineering drawing will communicate information to others more effectively Reflect and analyze best way to create design project	• Creation of detail drawings from 3D models to industry standards • Review design online and apply constraints to project	2
8.2.12.ED.5 9.4.12.CT.2 8.2.12.ED.6 9.4.12.IML.3 9.4.12.IML.4	Explain how a proper engineering assembly drawing will communicate information to others more effectively Evaluate the intended audience	• Creation of assemblies utilizing different 3D models • Discuss the different ways of creating an exploded view with the end user in mind	• 2

Core Instructional & Supplemental Materials (including various levels of texts)	
Texts/Resources	*Notes*
Teacher provided videos on 3d modeling YouTube videos on 3D modeling Desktop computers 3D CAD software Dial Calipers 3D printer	

Accommodations and Modifications: Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students

Specific Strategies and Practices that Support Students with Disabilities:
Specific examples applied to the unit

- Use of visual and multisensory formats
- Use of assisted technology
- Use of prompts
- Modification of content and student products
- Testing accommodations
- Authentic assessments

Specific Strategies and Practices that Support Gifted & Talented Students:
Specific examples applied to the unit

- Adjusting the pace of lessons
- Curriculum compacting
- Inquiry-based instruction
- Independent study
- Higher-order thinking skills
- Interest-based content
- Student-driven instruction
- Real-world problems and scenarios

Specific Strategies and Practices that Support English Language Learners:
Specific examples applied to the unit

- Pre-teaching of vocabulary and concepts
- Visual learning, including graphic organizers
- Use of cognates to increase comprehension
- Teacher modeling
- Pairing students with beginning English language skills with students who have more advanced English language skills
- Scaffolding
- Word walls
- Sentence frames
- Think-pair-share
- Cooperative learning groups

Stage 1 Desired Results

Unit Title #: Unit 2: Engineering Equipment

Unit Summary: The Engineering Equipment unit will build on what was learned in Engineering Design 1 starting with hand tools, progressing into wood working tools and then ending with 3D printing and laser engraving. All will be utilized in Unit 3 during the creation of the CO2 Dragster and other projects over the year.

Unit Learning Targets

NJSLS Standards:

8.2.12.ED.3: Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis. mic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)***:**

- 9.3.12.AC.3 Comply with regulations and applicable codes to establish and manage a legal and safe workplace.
- 9.3.12.AC‑CST.9 Safely use and maintain appropriate tools, machinery, equipment and resources to accomplish construction project goals.
- 9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions

Computer Science & Design Thinking *(CS & DT)***:**

No CS used, DT above

Interdisciplinary Connections ELA, Math, VPA, etc

RI.CR.9–10.1
Cite strong and thorough textual evidence and make relevant connections to support analysis of what the text says explicitly as well as inferences drawn from the text.

RI.CI.9–10.2
Determine one or more central ideas of an informational text and analyze how it is developed and refined over the course of the text, including how it emerges and is shaped by specific details; provide an objective summary of the text.

RI.MF.9–10.6
Analyze, integrate, and evaluate multiple interpretations (e.g., charts, graphs, diagrams, videos) of a single text or text/s presented in different formats (visually, quantitatively) as well as in words in order to address a question or solve a problem.

SL.9–10.4
Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

Unit Essential Questions: (*Open-ended, Higher-order, Thought Provoking)*	**Unit Enduring Understandings: (***Statements that connect to EQ's summarizing important ideas and core processes that are central to a discipline and have lasting value beyond the classroom)*
What value does understanding how a piece of equipment works add to its safe operation? Why does each piece of equipment have its own set of rules? What preventative steps can be taken to ensure safety? How does choreographing physical movements aid in safety?	Learning how a piece of equipment works is an important aspect of its safe use. Each piece of equipment is unique and has its own set of rules and guidelines to follow for safe use. Safety in the lab focuses on taking preventative steps to avoid injuries. Planning physical movements prior to use helps in the safe operation of a piece of equipment.
Students will know: *(Content, Noun)*	**Students will be able to:** *(Verb Bloom's Taxonomy)*
Each piece of equipment and its strengths and weaknesses with regard to fabrication. Know how to operate equipment safely and productively. **Vocabulary**: Disk Sander, Dremel, Scroll Saw, Drill Press, Spindle Sander, Band Saw, Sanding Spindle/Drum, Foot, Collet, Table, Disc Brake, Chuck, Sanding Disc, Throat Plate, Chuck Key, Stepped Pulley, Spindle, Miter Gauge, Table Tilt Lock	Evaluate how something will need to be created and determine the best equipment to utilize. Apply safety protocols that have been learned and apply them to multiple types of equipment. Apply vocabulary in student reading, writing, speaking and listening.

Stage 2 Assessment Evidence

Summative Assessments:

Equipment Vocabulary quizzes
Dial Caliper quiz
Unit test

Formative Assessments:
Visual evaluation
Q&A

Common Benchmark Assessments:
Equipment Test

Alternative Assessments:
Hands-on operation

Stage 3 Learning Plan

Standard	***Skill***	***Learning Activities & Differentiation*** *(Asian American & Pacific Islanders, LGBTQ and People with Disabilites, Diversity, Equity & Inclusion [DEI],)*	***Timeframe*** *(Blocks)*

8.2.12.ED.1 9.3.12.AC.3 9.3.12.AC-CST.9 9.4.12.IML.3	Evaluate how something will need to be created and determine the best equipment to utilize. Apply safety protocols that have been learned and apply them to multiple types of equipment.	• Present operation and safety protocols for each machine • Identify all components of equipment • Perform checkout procedure on each machine	3
8.2.12.ED.1 9.3.12.AC.3 9.3.12.AC-CST.9 9.4.12.IML.3	Apply knowledge, safety and application of equipment to fabricate an artifact.	• Design a simple item that can be fabricated with equipment • Create items utilizing equipment.	2

Core Instructional & Supplemental Materials (including various levels of texts)	
Texts/Resources	*Notes*
Teacher provided videos on equipment use YouTube videos on equipment use 3D CAD software 3D printer Laser engraver Prototyping equipment Prototyping materials	

Accommodations and Modifications:
Students with Disabilities, English Language Learners,
Students at Risk of Failure, Students with 504s, Gifted & Talented Students

Specific Strategies and Practices that Support Students with Disabilities:
Specific examples applied to the unit

- Use of visual and multisensory formats
- Use of assisted technology
- Use of prompts
- Modification of content and student products
- Testing accommodations
- Authentic assessments

Specific Strategies and Practices that Support Gifted & Talented Students:
Specific examples applied to the unit

- Adjusting the pace of lessons
- Curriculum compacting
- Inquiry-based instruction
- Independent study
- Higher-order thinking skills
- Interest-based content
- Student-driven instruction
- Real-world problems and scenarios

Specific Strategies and Practices that Support English Language Learners:
Specific examples applied to the unit

- Pre-teaching of vocabulary and concepts
- Visual learning, including graphic organizers
- Use of cognates to increase comprehension

- Teacher modeling
- Pairing students with beginning English language skills with students who have more advanced English language skills
- Scaffolding
- Word walls
- Sentence frames
- Think-pair-share
- Cooperative learning groups

Stage 1 Desired Results

Unit Title #: Unit 3: CO2 Dragster

Unit Summary: The CO2 Dragster unit will utilize and reinforce what was learned in Unit 1 & 2 to design, 3D model, build and test a balsa wood dragster that meets the yearly TSA design competition.

Unit Learning Targets

NJSLS Standards:

• 8.2.12.ED.1: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
• 8.2.12.ED.2: Create scaled engineering drawings for a new product or system and make modification to increase optimization based on feedback
• 8.2.12.ED.3: Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis.
• 8.2.12.ED.5: Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).
• 8.2.12.ED.6: Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).
• 8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)***:**

• 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas
• 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
• 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
• 9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8)

• 9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).
• 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

Computer Science & Design Thinking *(CS & DT)***:**
See NJSLS section.

Interdisciplinary Connections ELA, Math, VPA, etc

RI.CR.9–10.1
Cite strong and thorough textual evidence and make relevant connections to support analysis of what the text says explicitly as well as inferences drawn from the text.

RI.CI.9–10.2
Determine one or more central ideas of an informational text and analyze how it is developed and refined over the course of the text, including how it emerges and is shaped by specific details; provide an objective summary of the text.

RI.MF.9–10.6
Analyze, integrate, and evaluate multiple interpretations (e.g., charts, graphs, diagrams, videos) of a single text or text/s presented in different formats (visually, quantitatively) as well as in words in order to address a question or solve a problem.

SL.9–10.4
Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

Unit Essential Questions: (*Open-ended, Higher-order, Thought Provoking)*	**Unit Enduring Understandings:** (*Statements that connect to EQ's summarizing important ideas and core processes that are central to a discipline and have lasting value beyond the classroom)*
What effect do various types of forces have on vehicles? What variables are important to consider when designing a vehicle for speed? How does drag affect vehicle speed? How does weight affect a vehicle's speed?	Vehicles must be designed strong enough to withstand the stresses that act upon them. Weight will have the largest influence on the speed of a vehicle. A vehicle's wind resistance is directly related to the amount of

What makes a vehicle efficient? How does a shape affect a vehicle's speed? How is the design process used when designing and creating new vehicle technologies?	surface area perpendicular to the direction of travel. The efficiency of a transportation device is mainly affected by wind resistance and drag. The factors that affect a vehicle's efficiency are deeply rooted in scientific and mathematical principles. Input from others will have a positive effect on a design.
Students will know: *(Content, Noun)* The different forces that act on a car. That weight is the largest influencing factor on the speed of a vehicle. How to determine the drag force. That shape will affect the amount of drag. Vocabulary: Aerodynamics, boundary layer, drag, drag coefficient, frontal area, laminar flow, lift, down force, media, physics, rear suction, skin friction, thrust, turbulent flow, tribology, weight	**Students will be able to:** *(Verb Bloom's Taxonomy)* Determine the best methods of creating a vehicle design using a 3D CAD system. Analyze the results of a wind tunnel test and use the information to justify design changes. Design and create a vehicle that travels as fast as possible. Calculate the wind resistance cross-section of a vehicle. Calculate the average speed of a vehicle over a closed course. Calculate the drag coefficient of a vehicle. Conduct physical wind tunnel testing of a vehicle and interpret the results. Apply vocabulary in student reading, writing, speaking and listening.

Stage 2 Assessment Evidence

Summative Assessments:

Creation of muti-view and pictorial engineering drawings of 3D CAD parts
Vocabulary quizzes

Engineering Drawing Portfolio
Creation of dragster
Project presentation or report

Formative Assessments:

Creation of engineering drawings.
Creation of digital objects using a 3D CAD system.
Designing a product using a 3D CAD system.
Interim design calculations.
Wind tunnel testing.
Presentation/discussion of designed parts.
Assembly of parts in 3D CAD system.

Common Benchmark Assessments:

Creation of muti-view and pictorial engineering drawings of 3D CAD parts

Alternative Assessments:

Multimedia presentation on design project

Stage 3 Learning Plan

Standard	***Skill***	***Learning Activities & Differentiation*** *(Asian American & Pacific Islanders, LGBTQ and People with Disabilites, Diversity, Equity & Inclusion [DEI],)*	***Timeframe*** *(Blocks)*
8.2.12.ED.1 8.2.12.ED.3	Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.	• Present project and requirements • Perform research on types of dragsters	1

8.2.12.ED.5	Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints	• Present technical information regarding project	
9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice	• Begin design process • Sketch a variety of designs • Research designs and technical information regarding project	2
8.2.12.ED.5 8.2.12.ED.6 8.2.12.NT.1 9.4.12.CI.1 9.4.12.CT.2 9.4.12.TL.2	Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints Analyze the effects of changing resources when designing a specific product or system Explain how different groups can contribute to the overall design of a product. Demonstrate the ability to reflect, analyze, and use creative skills and ideas Explain the potential benefits of collaborating to enhance critical thinking and problem solving Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.	• Perform calculations to determine relevant data to be used for design • Create 3D models of various parts • Collaborate with others on design changes utilizing research, calculations and past experience to improve design	2
8.2.12.ED.2	Create scaled engineering drawings for a new product or system and make	• Create detailed engineering drawings	2

	modification to increase optimization based on feedback	• Create assemblies of models along with assembly drawings	
9.4.12.IML.3 9.4.12.IML.4	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions Assess and critique the appropriateness and impact of existing data visualizations for an intended audience	• Test projects and analyze data • Create a deliverable for intended audience	1

Core Instructional & Supplemental Materials (including various levels of texts)	
Texts/Resources	*Notes*
Teacher provided videos on 3d modeling YouTube videos on 3D modeling Desktop computers 3D CAD software Physical wind tunnel Calipers 3D printer Laser engraver Prototyping equipment Prototyping materials	

Accommodations and Modifications: Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students

Specific Strategies and Practices that Support Students with Disabilities:
Specific examples applied to the unit

- Use of visual and multisensory formats
- Use of assisted technology
- Use of prompts
- Modification of content and student products
- Testing accommodations
- Authentic assessments

Specific Strategies and Practices that Support Gifted & Talented Students:
Specific examples applied to the unit

- Adjusting the pace of lessons
- Curriculum compacting
- Inquiry-based instruction
- Independent study
- Higher-order thinking skills
- Interest-based content
- Student-driven instruction
- Real-world problems and scenarios

Specific Strategies and Practices that Support English Language Learners:
Specific examples applied to the unit

- Pre-teaching of vocabulary and concepts
- Visual learning, including graphic organizers
- Use of cognates to increase comprehension
- Teacher modeling
- Pairing students with beginning English language skills with students who have more advanced English language skills
- Scaffolding
- Word walls
- Sentence frames
- Think-pair-share
- Cooperative learning groups

Stage 1 Desired Results

Unit Title #: Unit 4: Computer System

Unit Summary: The Computer System unit will be an introduction to typical computer systems, how they are built and what they are composed of.

Unit Learning Targets

NJSLS Standards:

• 8.2.12.ED.1: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
• 8.2.12.ED.2: Create scaled engineering drawings for a new product or system and make modification to increase optimization based on feedback
• 8.2.12.ED.3: Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis.
• 8.1.12.CS.2: Model interactions between application software, system software, and hardware.
• 8.1.12.CS.3: Compare the functions of application software, system software, and hardware.
• 8.1.12.CS.4: Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.
• 8.2.12.ITH.2: Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs, and risks related to the use of the innovation.
• 8.2.12.ITH.3: Analyze the impact that globalization, social media, and access to open source technologies has had on innovation and on a society's economy, politics, and culture.

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)***:**

• 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas
• 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
• 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).

Computer Science & Design Thinking *(CS & DT)***:**

See NJSLS section.

Interdisciplinary Connections ELA, Math, VPA, etc

RI.CR.9–10.1
Cite strong and thorough textual evidence and make relevant connections to support analysis of what the text says explicitly as well as inferences drawn from the text.

RI.CI.9–10.2
Determine one or more central ideas of an informational text and analyze how it is developed and refined over the course of the text, including how it emerges and is shaped by specific details; provide an objective summary of the text.

RI.MF.9–10.6
Analyze, integrate, and evaluate multiple interpretations (e.g., charts, graphs, diagrams, videos) of a single text or text/s presented in different formats (visually, quantitatively) as well as in words in order to address a question or solve a problem.

SL.9–10.4
Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and tasks

Unit Essential Questions: (*Open-ended, Higher-order, Thought Provoking)*	**Unit Enduring Understandings:** (*Statements that connect to EQ's summarizing important ideas and core processes that are central to a discipline and have lasting value beyond the classroom)*
How do you think an operating system works? How do all the components in a pc work together?	Operating systems allow all the hardware in a pc to work. PC and software constantly increase capability. There are different types of computer operating systems depending on what is required of a particular computer.
Students will know: *(Content, Noun)* Know the components that make up a pc.	**Students will be able to:** *(Verb Bloom's Taxonomy)* Disassemble and assemble a pc.

Know the capabilities of a pc. Know the costs of components of the pc. Vocabulary: motherboard, SSD, RAM, HDMI, bus, directory, device tree, firmware, flashing, GPU, kernel, Linux, Windows, DOS, iOS	Differentiate between a variety of operating systems. Compare and contrast components of a pc Design an improvement in the cooling capability of a PC.

Stage 2 Assessment Evidence

Summative Assessments:

Vocabulary quizzes
Operating System quiz
Project Demonstration
Project presentation or report

Formative Assessments:

Disassembly and assembly of a pc
Pricing of pc components
Creation of digital objects using a 3D CAD system.
Designing a product using a 3D CAD system.
Presentation of designed parts.
Assembly of parts in 3D CAD system.

Common Benchmark Assessments:

TBD

Alternative Assessments:
Multimedia presentation on design project

Stage 3 Learning Plan

Standard	***Skill***	***Learning Activities & Differentiation*** *(Asian American & Pacific Islanders, LGBTQ and People with Disabilites, Diversity, Equity & Inclusion [DEI],)*	***Timeframe*** *(Blocks)*
8.1.12.CS.2 8.1.12.CS.3	Model interactions between application software, system software, and hardware. Compare the functions of application software, system software, and hardware.	• Present technical information regarding project • Present hardware • disassembly of pc • identification of parts • specifying commonly available parts	2
8.1.12.CS.4 8.2.12.ITH.3	Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors. Analyze the impact that open source technologies have had on innovation and on a society's economy, politics, and culture.	• Assemble pc and load firmware and operating systems	1
8.2.12.ED.1 8.2.12.ED.3 8.2.12.ED.5	Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.	• Present project and requirements • Perform research on how to cool a processor	1

	Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints		
9.4.12.CT.1 8.2.12.ITH.2	Identify problem-solving strategies used in the development of an innovative product or practice Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs, and risks related to the use of the innovation.	● Collaborate with project members to determine a project direction ● Develop the project via discussion, 3D modeling, prototyping and coding.	3
8.2.12.ED.5 8.2.12.ED.6 8.2.12.NT.1 9.4.12.CI.1 9.4.12.CT.2 9.4.12.TL.2	Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints Analyze the effects of changing resources when designing a specific product or system Explain how different groups can contribute to the overall design of a product. Demonstrate the ability to reflect, analyze, and use creative skills and ideas Explain the potential benefits of collaborating to enhance critical thinking and problem solving Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.	● Create 3D models of various parts ● Prototype system ● Collaborate with others on design changes utilizing research, calculations and past experience to improve design ● Test and present project to class via video	4

Core Instructional & Supplemental Materials (including various levels of texts)	
Texts/Resources	*Notes*
Teacher provided videos on PC YouTube videos on PC	

Accommodations and Modifications: Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students

Specific Strategies and Practices that Support Students with Disabilities:
Specific examples applied to the unit

- Use of visual and multisensory formats
- Use of assisted technology
- Use of prompts
- Modification of content and student products
- Testing accommodations
- Authentic assessments

Specific Strategies and Practices that Support Gifted & Talented Students:
Specific examples applied to the unit

- Adjusting the pace of lessons
- Curriculum compacting
- Inquiry-based instruction
- Independent study
- Higher-order thinking skills
- Interest-based content
- Student-driven instruction

- Real-world problems and scenarios

Specific Strategies and Practices that Support English Language Learners:
Specific examples applied to the unit

- Pre-teaching of vocabulary and concepts
- Visual learning, including graphic organizers
- Use of cognates to increase comprehension
- Teacher modeling
- Pairing students with beginning English language skills with students who have more advanced English language skills
- Scaffolding
- Word walls
- Sentence frames
- Think-pair-share
- Cooperative learning groups

Stage 1 Desired Results

Unit Title #: Unit 5: Aerodynamics

Unit Summary: The Aerodynamics unit will utilize research and engineering relationships/equations to design, 3D model and build a glider.

Unit Learning Targets

NJSLS Standards:

• 8.2.12.ED.1: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
• 8.2.12.ED.2: Create scaled engineering drawings for a new product or system and make modification to increase optimization based on feedback
• 8.2.12.ED.3: Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis.
• 8.2.12.ED.5: Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).
• 8.2.12.ED.6: Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).
• 8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

Interdisciplinary Connections
Career Readiness, Life Literacies, & Key Skills *(CLKS)***:** • 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas • 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3). • 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a). • 9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8) • 9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4). • 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
Computer Science & Design Thinking *(CS & DT)***:** **See NJSLS section.**
Interdisciplinary Connections ELA, Math, VPA, etc RI.CR.9–10.1 Cite strong and thorough textual evidence and make relevant connections to support analysis of what the text says explicitly as well as inferences drawn from the text. RI.CI.9–10.2 Determine one or more central ideas of an informational text and analyze how it is developed and refined over the course of the text, including how it emerges and is shaped by specific details; provide an objective summary of the text. RI.MF.9–10.6 Analyze, integrate, and evaluate multiple interpretations (e.g., charts, graphs, diagrams, videos) of a single text or text/s presented in different formats (visually, quantitatively) as well as in words in order to address a question or solve a problem. SL.9–10.4 Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

Unit Essential Questions: (*Open-ended, Higher-order, Thought Provoking)*	**Unit Enduring Understandings:** (*Statements that connect to EQ's summarizing important ideas and core processes that are central to a discipline and have lasting value beyond the classroom)*
What effect do various types of forces have on a plane? What variables are important to consider when designing a plane to remain in the air for a long time? How does drag affect a plane's time in the air? How does weight affect a plane's time in the air? What makes a plane efficient? How does a shape affect a plane's speed? How is the design process used when designing and creating new vehicle technologies?	Planes must be designed strong enough to withstand the stresses that act upon them. Weight will have the largest influence on a plane remaining airborne. A plane's wind resistance is directly related to the amount of surface area perpendicular to the direction of travel. The efficiency of a transportation device is mainly affected by wind resistance and drag. The factors that affect a plane's efficiency are deeply rooted in scientific and mathematical principles. Input from others will have a positive effect on a design.
Students will know: *(Content, Noun)* The different forces that act on a plane. That weight is the largest influencing factor on the speed of a plane. How to determine design parameters of a glider. That the shape of a plane's wing will affect the amount of drag and lift. Vocabulary: aileron, airfoil, angle of attack, aspect ratio, camber, camber line, chord line, dihedral, elevators, flaps, fuselage, glide ratio, leading edge, horizontal stabilizer, pitch, roll, rudder, tail, trailing edge, vertical stabilizer, stall, wing, wing loading, winglet, yaw	**Students will be able to:** *(Verb Bloom's Taxonomy)* Determine the best methods of creating a plane design using a 3D CAD system. Analyze the results of a wind tunnel test and use the information to justify design changes. Design and create a glider that remains in the air as long as possible. Calculate the design parameters of a glider. Calculate the glide ratio of a glider. Apply vocabulary in student reading, writing, speaking and listening.

Stage 2 Assessment Evidence

Summative Assessments:

Creation of muti-view and pictorial engineering drawings of 3D CAD parts
Vocabulary quizzes
Engineering Drawing Portfolio
Creation of glider
Project presentation or report

Formative Assessments:

Creation of engineering drawings.
Creation of digital objects using a 3D CAD system.
Designing a product using a 3D CAD system.
Interim design calculations.
Wind tunnel testing.
Presentation/discussion of designed parts.
Assembly of parts in 3D CAD system.

Common Benchmark Assessments:

Creation of muti-view and pictorial engineering drawings of 3D CAD parts

Alternative Assessments:

Multimedia presentation on design project

Stage 3 Learning Plan

Standard	***Skill***	***Learning Activities & Differentiation*** *(Asian American & Pacific Islanders, LGBTQ and People with Disabilites, Diversity, Equity & Inclusion [DEI],)*	***Timeframe*** *(Blocks)*
8.2.12.ED.1 8.2.12.ED.3 8.2.12.ED.5	Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers. Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints	• Present project and requirements • Perform research on gliders • Present technical information regarding project	1
9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice	• Begin design process • Research designs and technical information regarding project	2
8.2.12.ED.5 8.2.12.ED.6 8.2.12.NT.1 9.4.12.CI.1 9.4.12.CT.2 9.4.12.TL.2	Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints Analyze the effects of changing resources when designing a specific product or system Explain how different groups can contribute to the overall design of a product. Demonstrate the ability to reflect, analyze, and use creative skills and ideas Explain the potential benefits of collaborating to enhance critical thinking	• Create 3D models of gliders • Collaborate with others on design changes utilizing research, calculations and past experience to improve design	3

	and problem solving Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.		
9.4.12.IML.3 9.4.12.IML.4	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions Assess and critique the appropriateness and impact of existing data visualizations for an intended audience	• Test projects and analyze data • Create a deliverable for intended audience	2

Core Instructional & Supplemental Materials (including various levels of texts)	
Texts/Resources	*Notes*
Teacher provided videos on 3d modeling YouTube videos on 3D modeling Desktop computers 3D CAD software Physical wind tunnel Calipers 3D printer Laser engraver Prototyping equipment Prototyping materials	

Accommodations and Modifications:

Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students

Specific Strategies and Practices that Support Students with Disabilities:
Specific examples applied to the unit

- Use of visual and multisensory formats
- Use of assisted technology
- Use of prompts
- Modification of content and student products
- Testing accommodations
- Authentic assessments

Specific Strategies and Practices that Support Gifted & Talented Students:
Specific examples applied to the unit

- Adjusting the pace of lessons
- Curriculum compacting
- Inquiry-based instruction
- Independent study
- Higher-order thinking skills
- Interest-based content
- Student-driven instruction
- Real-world problems and scenarios

Specific Strategies and Practices that Support English Language Learners:
Specific examples applied to the unit

- Pre-teaching of vocabulary and concepts
- Visual learning, including graphic organizers
- Use of cognates to increase comprehension
- Teacher modeling
- Pairing students with beginning English language skills with students who have more advanced English language skills
- Scaffolding
- Word walls
- Sentence frames

- Think-pair-share
- Cooperative learning groups

Stage 1 Desired Results

Unit Title #: Unit 6: Buoyancy

Unit Summary: The Buoyancy unit will allow students to better understand how one item may float but another would sink.

Unit Learning Targets

NJSLS Standards:

• 8.2.12.ED.1: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
• 8.2.12.ED.2: Create scaled engineering drawings for a new product or system and make modification to increase optimization based on feedback
• 8.2.12.ED.3: Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis.
• 8.2.12.ED.5: Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).
• 8.2.12.ED.6: Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).
• 8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)***:**

• 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas
• 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
• 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
• 9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8)
• 9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).
• 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

Computer Science & Design Thinking *(CS & DT)***:**

See NJSLS section.

Interdisciplinary Connections ELA, Math, VPA, etc

RI.CR.9–10.1
Cite strong and thorough textual evidence and make relevant connections to support analysis of what the text says explicitly as well as inferences drawn from the text.

RI.CI.9–10.2
Determine one or more central ideas of an informational text and analyze how it is developed and refined over the course of the text, including how it emerges and is shaped by specific details; provide an objective summary of the text.

RI.MF.9–10.6
Analyze, integrate, and evaluate multiple interpretations (e.g., charts, graphs, diagrams, videos) of a single text or text/s presented in different formats (visually, quantitatively) as well as in words in order to address a question or solve a problem.

SL.9–10.4
Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

Unit Essential Questions: (*Open-ended, Higher-order, Thought Provoking)*	**Unit Enduring Understandings:** (*Statements that connect to EQ's summarizing important ideas and core processes that are central to a discipline and have lasting value beyond the classroom)*
What effect do various types of forces have on a ship? What variables are important to consider when designing a ship? How does a ship's displacement of water affect buoyancy? How does the weight affect a ship's buoyancy? What makes a ship efficient? How does a shape affect a ship's speed? How is the design process used when designing and creating new vehicle technologies?	Ships must be designed strong enough to withstand the stresses that act upon them. Water displacement will have the largest influence on a ship's ability to float. The efficiency of a transportation device is mainly affected by weight and resistance to drag. The factors that affect a ship's efficiency are deeply rooted in scientific and mathematical principles. Input from others will have a positive effect on a design.
Students will know: *(Content, Noun)*	**Students will be able to:** *(Verb Bloom's Taxonomy)*

The different forces that act on a ship. That displacement of water is the largest factor on the buoyancy of a ship. That the shape of a ship's hull will affect the amount of drag. Vocabulary: buoyancy, density, mass, mass density, pressure, volume, weight.	Determine the best methods of creating a ship design using a 3D CAD system. Design and create a ship that remains buoyant as long as possible. Calculate the design parameters of a ship. Calculate the parameters of buoyancy.. Apply vocabulary in student reading, writing, speaking and listening.

Stage 2 Assessment Evidence

Summative Assessments:

Creation of muti-view and pictorial engineering drawings of 3D CAD parts
Vocabulary quizzes
Engineering Drawing Portfolio
Creation of ship
Project presentation or report

Formative Assessments:

Creation of engineering drawings.
Creation of digital objects using a 3D CAD system.
Designing a product using a 3D CAD system.
Interim design calculations.
Wind tunnel testing.
Presentation/discussion of designed parts.
Assembly of parts in 3D CAD system.

Common Benchmark Assessments:
Creation of muti-view and pictorial engineering drawings of 3D CAD parts

Alternative Assessments:
Multimedia presentation on design project

Stage 3 Learning Plan

Standard	***Skill***	***Learning Activities & Differentiation*** *(Asian American & Pacific Islanders, LGBTQ and People with Disabilites, Diversity, Equity & Inclusion [DEI],)*	***Timeframe*** *(Blocks)*
8.2.12.ED.1 8.2.12.ED.3 8.2.12.ED.5	Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers. Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints	• Present project and requirements • Perform research on buoyancy • Present technical information regarding project	1
9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice	• Begin design process • Research designs and technical information regarding project	2
8.2.12.ED.5 8.2.12.ED.6 8.2.12.NT.1	Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints	• Create 3D models of ships	3

9.4.12.CI.1 9.4.12.CT.2 9.4.12.TL.2	Analyze the effects of changing resources when designing a specific product or system Explain how different groups can contribute to the overall design of a product. Demonstrate the ability to reflect, analyze, and use creative skills and ideas Explain the potential benefits of collaborating to enhance critical thinking and problem solving Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.	• Collaborate with others on design changes utilizing research, calculations and past experience to improve design	
9.4.12.IML.3 9.4.12.IML.4	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions Assess and critique the appropriateness and impact of existing data visualizations for an intended audience	• Test projects and analyze data • Create a deliverable for intended audience	2

Core Instructional & Supplemental Materials (including various levels of texts)	
Texts/Resources	*Notes*
Teacher provided videos on 3d modeling YouTube videos on 3D modeling Desktop computers	

3D CAD software Physical wind tunnel Calipers 3D printer Laser engraver Prototyping equipment Prototyping materials	

Accommodations and Modifications:
Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students

Specific Strategies and Practices that Support Students with Disabilities:
Specific examples applied to the unit

- Use of visual and multisensory formats
- Use of assisted technology
- Use of prompts
- Modification of content and student products
- Testing accommodations
- Authentic assessments

Specific Strategies and Practices that Support Gifted & Talented Students:
Specific examples applied to the unit

- Adjusting the pace of lessons
- Curriculum compacting
- Inquiry-based instruction
- Independent study
- Higher-order thinking skills
- Interest-based content

- Student-driven instruction
- Real-world problems and scenarios

Specific Strategies and Practices that Support English Language Learners:
Specific examples applied to the unit

- Pre-teaching of vocabulary and concepts
- Visual learning, including graphic organizers
- Use of cognates to increase comprehension
- Teacher modeling
- Pairing students with beginning English language skills with students who have more advanced English language skills
- Scaffolding
- Word walls
- Sentence frames
- Think-pair-share
- Cooperative learning groups

Stage 1 Desired Results

Unit Title #: Unit 7: Hydraulics & Pneumatics

Unit Summary: The Hydraulics & Pneumatics unit will allow students to research, design and build an articulated arm robot that is controlled via hydraulic and pneumatics.

Unit Learning Targets

NJSLS Standards:

• 8.2.12.ED.1: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
• 8.2.12.ED.2: Create scaled engineering drawings for a new product or system and make modification to increase optimization based on feedback
• 8.2.12.ED.3: Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis.
• 8.2.12.ED.5: Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).
• 8.2.12.ED.6: Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).
• 8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)*:

• 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas
• 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
• 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
• 9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8)
• 9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).
• 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

Computer Science & Design Thinking *(CS & DT)*:

See NJSLS section.

Interdisciplinary Connections ELA, Math, VPA, etc

RI.CR.9–10.1
Cite strong and thorough textual evidence and make relevant connections to support analysis of what the text says explicitly as well as inferences drawn from the text.

RI.CI.9–10.2
Determine one or more central ideas of an informational text and analyze how it is developed and refined over the course of the text, including how it emerges and is shaped by specific details; provide an objective summary of the text.

RI.MF.9–10.6
Analyze, integrate, and evaluate multiple interpretations (e.g., charts, graphs, diagrams, videos) of a single text or text/s presented in different formats (visually, quantitatively) as well as in words in order to address a question or solve a problem.

SL.9–10.4
Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

Unit Essential Questions: (*Open-ended, Higher-order, Thought Provoking)*	**Unit Enduring Understandings:** (*Statements that connect to EQ's summarizing important ideas and core processes that are central to a discipline and have lasting value beyond the classroom)*
How does hydraulics differ from pneumatics? What are the pros and cons of H & P? Which can develop more force for a given cylinder size? Which is more efficient?	Liquids (Hydraulics fluid) is not compressible, but gasses (pneumatics) are. Hydraulic systems can operate at a much higher pressure than pneumatics. Hydraulics can be messier if a line breaks.
Students will know: *(Content, Noun)* That F= PxA A cylinder's speed is determined by the rate of flow and the diameter of the cylinder. A cylinder's force is determined by the amount of pressure and the diameter of the cylinder. That H&P systems could utilize single or double acting cylinders. Vocabulary: hydraulic, pneumatic, compressible, non-compressible, pressure, flow rate, force, displacement, articulated arm robot	**Students will be able to:** *(Verb Bloom's Taxonomy)* Design an articulated arm robot that is controlled by H&P Calculate the force generated given different parameters. Calculate the speed generated given different parameters. Apply vocabulary in student reading, writing, speaking and listening.

Stage 2 Assessment Evidence

Summative Assessments:

Creation of muti-view and pictorial engineering drawings of 3D CAD parts
Vocabulary quizzes

Engineering Drawing Portfolio
Creation of robot
Project presentation or report

Formative Assessments:

Creation of engineering drawings.
Creation of digital objects using a 3D CAD system.
Designing a product using a 3D CAD system.
Interim design calculations.
Presentation/discussion of designed parts.
Assembly of parts in 3D CAD system.

Common Benchmark Assessments:

System calculations for hydraulic or pneumatic systems.

Alternative Assessments:

Multimedia presentation on design project

Stage 3 Learning Plan

Standard	***Skill***	***Learning Activities & Differentiation*** *(Asian American & Pacific Islanders, LGBTQ and People with Disabilites, Diversity, Equity & Inclusion [DEI],)*	***Timeframe*** *(Blocks)*
8.2.12.ED.1 8.2.12.ED.3 8.2.12.ED.5	Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.	• Present project and requirements • Perform research on buoyancy • Present technical information regarding project	2

	Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints		
9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice	• Begin design process • Research designs and technical information regarding project	3
8.2.12.ED.5 8.2.12.ED.6 8.2.12.NT.1 9.4.12.CI.1 9.4.12.CT.2 9.4.12.TL.2	Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints Analyze the effects of changing resources when designing a specific product or system Explain how different groups can contribute to the overall design of a product. Demonstrate the ability to reflect, analyze, and use creative skills and ideas Explain the potential benefits of collaborating to enhance critical thinking and problem solving Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.	• Create 3D models of robots and controllers • Collaborate with others on design changes utilizing research, calculations and past experience to improve design	5
9.4.12.IML.3 9.4.12.IML.4	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions Assess and critique the appropriateness and	• Test projects and analyze data • Create a deliverable for intended audience • Present system operation	3

	impact of existing data visualizations for an intended audience		

Core Instructional & Supplemental Materials (including various levels of texts)	
Texts/Resources	*Notes*
Teacher provided videos on hydraulics and pneumatics YouTube videos on hydraulics and pneumatics Desktop computers 3D CAD software Calipers 3D printer CNC Router Laser engraver Prototyping equipment Prototyping materials	

Accommodations and Modifications:
Students with Disabilities, English Language Learners,
Students at Risk of Failure, Students with 504s, Gifted & Talented Students

Specific Strategies and Practices that Support Students with Disabilities:
Specific examples applied to the unit

- Use of visual and multisensory formats
- Use of assisted technology
- Use of prompts

- Modification of content and student products
- Testing accommodations
- Authentic assessments

Specific Strategies and Practices that Support Gifted & Talented Students:
Specific examples applied to the unit

- Adjusting the pace of lessons
- Curriculum compacting
- Inquiry-based instruction
- Independent study
- Higher-order thinking skills
- Interest-based content
- Student-driven instruction
- Real-world problems and scenarios

Specific Strategies and Practices that Support English Language Learners:
Specific examples applied to the unit

- Pre-teaching of vocabulary and concepts
- Visual learning, including graphic organizers
- Use of cognates to increase comprehension
- Teacher modeling
- Pairing students with beginning English language skills with students who have more advanced English language skills
- Scaffolding
- Word walls
- Sentence frames
- Think-pair-share
- Cooperative learning groups

Stage 1 Desired Results

Unit Title #: Unit 8: Projectile Motion

Unit Summary: The Projectile Motion unit will utilize physics calculations and animations to teach students about projectile motion Students will also be creating water rockets.

Unit Learning Targets

NJSLS Standards:

• 8.2.12.ED.1: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
• 8.2.12.ED.2: Create scaled engineering drawings for a new product or system and make modification to increase optimization based on feedback
• 8.2.12.ED.3: Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis.
• 8.2.12.ED.5: Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics).
• 8.2.12.ED.6: Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).
• 8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product.

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)***:**

• 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas
• 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
• 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
• 9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8)
• 9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).
• 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

Computer Science & Design Thinking *(CS & DT)***:**

See NJSLS section.

Interdisciplinary Connections ELA, Math, VPA, etc

RI.CR.9–10.1
Cite strong and thorough textual evidence and make relevant connections to support analysis of what the text says explicitly as well as inferences drawn from the text.

RI.CI.9–10.2
Determine one or more central ideas of an informational text and analyze how it is developed and refined over the course of the text, including how it emerges and is shaped by specific details; provide an objective summary of the text.

RI.MF.9–10.6
Analyze, integrate, and evaluate multiple interpretations (e.g., charts, graphs, diagrams, videos) of a single text or text/s presented in different formats (visually, quantitatively) as well as in words in order to address a question or solve a problem.

SL.9–10.4
Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task

Unit Essential Questions: (*Open-ended, Higher-order, Thought Provoking)*	**Unit Enduring Understandings:** (*Statements that connect to EQ's summarizing important ideas and core processes that are central to a discipline and have lasting value beyond the classroom)*
What effect do various types of forces have on a rocket? How gravity affects rocket travel? What variables are important to consider when designing a rocket to remain in the air for a long time? How does drag affect a rocket's time in the air? How does weight affect a rocket's time in the air? What makes a rocket efficient? How does a shape affect a rocket's speed? How is the design process used when designing and creating new vehicle technologies?	Gravity only affects the velocity in the y direction. Drag affects an object in the opposite direction of travel. Rockets must be designed strong enough to withstand the stresses that act upon them. Weight will have the largest influence on a rocket remaining airborne. A rocket's wind resistance is directly related to the amount of surface area perpendicular to the direction of travel. The efficiency of a transportation device is mainly affected by wind resistance and drag. The factors that affect a rocket's efficiency are deeply rooted in scientific and mathematical principles. Input from others will have a positive effect on a design.
Students will know: *(Content, Noun)* The different forces that act on a rocket.	**Students will be able to:** *(Verb Bloom's Taxonomy)* Determine the best methods of creating a rocket design using a 3D CAD system.

That weight is the largest influencing factor on the height a rocket can travel. How to determine design parameters of a rocket. Vocabulary:propellant,psi,apogee,ballistic flight,center of gravity,weather cocking,vector quantities, projected area,center of pressure,terminal velocity	Design and create a rocket that remains in the air as long as possible. Calculate the design parameters of a rocket. Calculate the height of a launched rocket. Apply vocabulary in student reading, writing, speaking and listening.

Stage 2 Assessment Evidence

Summative Assessments:

Creation of muti-view and pictorial engineering drawings of 3D CAD parts
Design calculations
Vocabulary quizzes
Project presentation or report

Formative Assessments:

Creation of engineering drawings.
Creation of digital objects using a 3D CAD system.
Designing a product using a 3D CAD system.
Presentation of designed parts.
Construction of rocket

Common Benchmark Assessments:
Creation of muti-view and pictorial engineering drawings of 3D CAD parts

Alternative Assessments:
Multimedia presentation on design project

Stage 3 Learning Plan

Standard	***Skill***	***Learning Activities & Differentiation*** *(Asian American & Pacific Islanders, LGBTQ and People with Disabilites, Diversity, Equity & Inclusion [DEI],)*	***Timeframe*** *(Blocks)*
8.2.12.ED.1 8.2.12.ED.3 8.2.12.ED.5	Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers. Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints	• Present project and requirements • Perform research on types of projectiles • Present technical information regarding project	2
9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice	• Begin design process • Research designs and technical information regarding project	2
8.2.12.ED.5 8.2.12.ED.6 8.2.12.NT.1	Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints	• Create 3D models of projectiles	4

9.4.12.CI.1 9.4.12.CT.2 9.4.12.TL.2	Analyze the effects of changing resources when designing a specific product or system Explain how different groups can contribute to the overall design of a product. Demonstrate the ability to reflect, analyze, and use creative skills and ideas Explain the potential benefits of collaborating to enhance critical thinking and problem solving Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.	• Collaborate with others on design changes utilizing research, calculations and past experience to improve design	
9.4.12.IML.3 9.4.12.IML.4	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions Assess and critique the appropriateness and impact of existing data visualizations for an intended audience	• Test projects and analyze data • Create a deliverable for intended audience	3

Core Instructional & Supplemental Materials (including various levels of texts)	
Texts/Resources	*Notes*
Teacher provided videos on projectile motion YouTube videos on projectile motion Desktop computers 3D CAD software Calipers	

3D printer CNC Router Laser engraver Prototyping equipment Prototyping materials	

Accommodations and Modifications:
Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students

Specific Strategies and Practices that Support Students with Disabilities:
Specific examples applied to the unit

- Use of visual and multisensory formats
- Use of assisted technology
- Use of prompts
- Modification of content and student products
- Testing accommodations
- Authentic assessments

Specific Strategies and Practices that Support Gifted & Talented Students:
Specific examples applied to the unit

- Adjusting the pace of lessons
- Curriculum compacting
- Inquiry-based instruction
- Independent study
- Higher-order thinking skills
- Interest-based content
- Student-driven instruction
- Real-world problems and scenarios

Specific Strategies and Practices that Support English Language Learners:
Specific examples applied to the unit

- Pre-teaching of vocabulary and concepts
- Visual learning, including graphic organizers
- Use of cognates to increase comprehension
- Teacher modeling
- Pairing students with beginning English language skills with students who have more advanced English language skills
- Scaffolding
- Word walls
- Sentence frames
- Think-pair-share
- Cooperative learning groups

Stage 1 Desired Results

Unit Title #: Unit 9: Drones & Photogrammetry

Unit Summary: The Drones & Photogrammetry unit will be utilizing drones that will then be used to take copious pictures to recreate something as a 3D model in conjunction with a photogrammetry software.

Unit Learning Targets

NJSLS Standards:

• 8.1.12.IC.3: Predict the potential impacts and implications of emerging technologies on larger social, economic, and political structures, using evidence from credible sources.
• 8.2.12.ITH.2: Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs, and risks related to the use of the innovation.
• 8.2.12.ITH.2: Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs, and risks related to the use of the innovation.
• 8.2.12.ITH.3: Analyze the impact that globalization, social media, and access to open source technologies has had on innovation and on a society's economy, politics, and culture.

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)***:**

• 9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

• 9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience.

Computer Science & Design Thinking *(CS & DT)***:**
See NJSLS section.

Interdisciplinary Connections ELA, Math, VPA, etc

RI.CR.9–10.1
Cite strong and thorough textual evidence and make relevant connections to support analysis of what the text says explicitly as well as inferences drawn from the text.

RI.CI.9–10.2
Determine one or more central ideas of an informational text and analyze how it is developed and refined over the course of the text, including how it emerges and is shaped by specific details; provide an objective summary of the text.

RI.MF.9–10.6
Analyze, integrate, and evaluate multiple interpretations (e.g., charts, graphs, diagrams, videos) of a single text or text/s presented in different formats (visually, quantitatively) as well as in words in order to address a question or solve a problem.

SL.9–10.4
Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

Unit Essential Questions: (*Open-ended, Higher-order, Thought Provoking)*	**Unit Enduring Understandings:** (*Statements that connect to EQ's summarizing important ideas and core processes that are central to a discipline and have lasting value beyond the classroom)*
What are some applications utilizing drones? How have drones changed different industries? What is the future of drones in engineering along with other fields? What are the limitations of drones? What are some applications utilizing photogrammetry? How has photogrammetry changed different industries?	The use of drones has changed the way industries gather data. There are different types of drones for different applications Drones manufactured in China are not allowed to be used in a government capacity. There are multiple career paths, across a wide range of disciplines, that utilize drones. Photogrammetry is used to electronically model large objects.

What is the future of photogrammetry in engineering along with other fields?	
Students will know: *(Content, Noun)* The components of a drone. How to manipulate a drone to acquire usable photos	**Students will be able to:** *(Verb Bloom's Taxonomy)* Create autonomous flight path programs to move a drone in a desired manner. Create 3D models from pictures taken by the drone

Stage 2 Assessment Evidence

Summative Assessments:
Vocabulary quiz
Minor drone flight demonstrations
Project presentation or report

Formative Assessments:
Presentation of final Python flight path
Creation of 3D objects utilizing photogrammetry.

Common Benchmark Assessments:
Demonstration of what has been taught half way through the project

Alternative Assessments:
Multimedia presentation on design project

Stage 3 Learning Plan			
Standard	***Skill***	***Learning Activities & Differentiation*** *(Asian American & Pacific Islanders, LGBTQ and People with Disabilites, Diversity, Equity & Inclusion [DEI],)*	***Timeframe*** *(Blocks)*
8.1.12.IC.3 8.2.12.ITH.2 8.2.12.ITH.3 8.2.12.ITH.3	Predict the potential impacts and implications of emerging technologies on larger social, economic, and political structures, using evidence from credible sources. Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs, and risks related to the use of the innovation . Analyze the impact that globalization, social media, and access to open source technologies has had on innovation and on a society's economy, politics, and culture.	• Present project and requirements • Perform research on types of drones and capabilities • Present technical information regarding drones and how to operate	2
		• Learn how to utilize drones manually and autonomously • Apply operational knowledge to multiple activities mimicking real life scenarios	6
9.4.12.IML.3 9.4.12.IML.4	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions. Assess and critique the appropriateness and impact of existing data visualizations for an intended audience.	• Introduce the use of Photogrammetry software to class • Collaborate with others on how to improve the final product: scanned model	2

		• Finalize project deliverables • Create a deliverable for intended audience	1

Core Instructional & Supplemental Materials (including various levels of texts)	
Texts/Resources	*Notes*
Teacher provided videos on Drones YouTube videos on Drones Desktop computers/Chromebooks Photogrammetry software 3D printer Laser engraver Prototyping equipment Prototyping materials Drones Drone operation	

Accommodations and Modifications: Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students
Specific Strategies and Practices that Support Students with Disabilities: ***Specific examples applied to the unit*** • Use of visual and multisensory formats

- Use of assisted technology
- Use of prompts
- Modification of content and student products
- Testing accommodations
- Authentic assessments

Specific Strategies and Practices that Support Gifted & Talented Students:
Specific examples applied to the unit

- Adjusting the pace of lessons
- Curriculum compacting
- Inquiry-based instruction
- Independent study
- Higher-order thinking skills
- Interest-based content
- Student-driven instruction
- Real-world problems and scenarios

Specific Strategies and Practices that Support English Language Learners:
Specific examples applied to the unit

- Pre-teaching of vocabulary and concepts
- Visual learning, including graphic organizers
- Use of cognates to increase comprehension
- Teacher modeling
- Pairing students with beginning English language skills with students who have more advanced English language skills
- Scaffolding
- Word walls
- Sentence frames
- Think-pair-share
- Cooperative learning groups