



**Middle School Technology Department  
6th Grade Tech Ed Curriculum Guide  
August 2023  
Revised**

Dr. Mark Toback, Superintendent  
Mrs. Donna Reichman, Assistant Superintendent

This curriculum may be modified through varying techniques, strategies, and materials  
as per an individual student's Individualized Educational Plan (IEP)

Approved by the Wayne Township Board of Education at the regular meeting held on

## Wayne School District Curriculum Format

<b>Content Area/ Grade Level/ Course:</b>	Unit 1 Grade 6 STEM
<b>Unit Plan Title:</b>	The Design and Problem-Solving Process
<b>Time Frame</b>	Two weeks

### 2020 New Jersey Student Learning Standards – Computer Science and Design Thinking

- 8.2.8.ED.1: Evaluate the function, value, and aesthetics of a technological product or system, from the perspective of the user and the producer.
- 8.2.8.ED.2: Identify the steps in the design process that could be used to solve a problem.
- 8.2.8.ED.3: Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).
- 8.2.8.ED.4: Investigate a malfunctioning system, identify its impact, and explain the step-by-step process used to troubleshoot, evaluate, and test options to repair the product in a collaborative team.
- 8.2.8.ED.5: Explain the need for optimization in a design process.
- 8.2.8.ED.6: Analyze how trade-offs can impact the design of a product.
- 8.2.8.ED.7: Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches).
- 8.2.8.ETW.1: Illustrate how a product is upcycled into a new product and analyze the short- and long-term benefits and costs.
- 8.2.8.ETW.2: Analyze the impact of modifying resources in a product or system (e.g., materials, energy, information, time, tools, people, capital).
- 8.2.8.ETW.3: Analyze the design of a product that negatively impacts the environment or society and develop possible solutions to lessen its impact.
- 8.2.8.ETW.4: Compare the environmental effects of two alternative technologies devised to address climate change issues and use data to justify which choice is best.
- 8.2.8.EC.1: Explain ethical issues that may arise from the use of new technologies.
- 8.2.8.EC.2: Examine the effects of ethical and unethical practices in product design and development.

### 2022 New Jersey Student Learning Standards for Science

- **MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.**
- **MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.**
  - **DCI:** The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful.
  - **PRACTICE:** Define a problem that can be solved through the development of an object, tool, process, or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.

- **CROSS-CUTTING CONCEPT:** All human activity draws on natural resources and has both short- and long-term consequences, positive as well as negative, for the health of people and the natural environment.
- **CROSS-CUTTING CONCEPT:** The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.
- **MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.**
  - **DCI:** There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.
  - **PRACTICE:** Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.
- **MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.**
  - **DCI:** Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design.
  - **PRACTICE:** Analyze and interpret data to determine similarities and differences in findings.
- **MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.**
  - **DCI:** The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.
  - **PRACTICE:** Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.

### Interdisciplinary Standards: New Jersey Student Learning Standards For English Language Arts Companion Standards Grade 6-8

#### NJSLS.ELA-LITERACY.RST.6-8.4

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6-8 texts and topics*.

#### NJSLS.ELA-LITERACY.RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

### Unit Summary

- In this unit, we use what is called "The Design and Problem-Solving Process." This is a multi-step procedure that is highly iterative—you may go back and forth among the listed steps, and may not always follow them in order. Remember that in most engineering projects, more than one good answer exists. The goal is to get to the best solution for a given problem. Scientists, engineers, and ordinary people use problem solving each day to work out solutions to various problems. Using a systematic and iterative procedure to solve a problem is efficient and provides a logical flow of knowledge and progress. Design is the planned process of change. Instead of something changing by accident, design demands that we plan change so that we end up with the results we want. It also means that we attempt to minimize trade-offs and control risk. Technology is all about design. Overarching themes of the engineering design process are teamwork and design. Strengthening students' understanding of open-ended design and encouraging them to work together to brainstorm new ideas, apply science and math concepts, test prototypes and analyze data—and aim for creativity and practicality in their solutions. After introduction to the design loop/problem solving process is introduced, explored and reviewed

students will be placed into teams who together will use the engineering design process to solve a variety of design challenges. The lesson closes with students sharing all they learned and discussing the answers to the many questions they had at the beginning of the lesson.

### Essential Question(s)

- Why do engineers and designers strive to improve products used in our daily lives?
- Why do we use the engineering design process to solve design challenges?
- How can the engineering design process benefit us in solving problems in our daily lives?
- How can engineering design be used to create solutions to a problem?
- How is it possible to find several valid solutions to a single problem?
- Why is it a good idea to keep testing a design?
- What specific goal are you trying to achieve, and how will you know if you've been successful?
- How does the design meet the criteria for success presented in the challenge?

### Enduring Understandings

- The Engineering Design Process is a method that is used to solve technological challenges to change and improve products for the way we live.
- The design process gives structure to creativity.
- The design loop allows engineers to find not "a" solution but the "best" solution to a problem.

In this unit plan, the following 21<sup>st</sup> Century themes and skills are addressed.

Check all that apply. 21 <sup>st</sup> Century Themes		Check all that apply. 21 <sup>st</sup> Century Skills	
<input checked="" type="checkbox"/>	Global Awareness	<input checked="" type="checkbox"/>	Creativity and Innovation
<input type="checkbox"/>	Environmental Literacy	<input checked="" type="checkbox"/>	Critical Thinking and Problem Solving
<input type="checkbox"/>	Health Literacy	<input checked="" type="checkbox"/>	Communication
<input type="checkbox"/>	Civic Literacy	<input checked="" type="checkbox"/>	Collaboration
<input checked="" type="checkbox"/>	Financial, Economic, Business, and Entrepreneurial Literacy		

### Student Learning Targets/Objectives (Students will know/Students will understand)

- That creativity is a process.
- The steps and function of each step of a design process.
- That engineering design is a multi-step process.
- Why revision and refinement are imperative to the design process.
- What a design loop is.

### Assessments (Pre, Formative, Summative, Other)

*Denote required common assessments with an \**

\*Quizzes/Tests – identify and organize a design loop.

Self-assessment of performance task

Teacher observation of student performance tasks for evidence of process and innovation.

Graphically represent the design loop used in the performance task.

### Teaching and Learning Activities

*Activities*

- Watch videos on each design process to help students to learn how to think creatively when solving a problem and strengthen their critical-thinking abilities.
- EDP design and build challenge (i.e. Toxic Popcorn, egg drop)

<p><i>Differentiation Strategies</i></p>	<p>Strategy and flexible groups based on formative assessment or student choice</p> <p>One:One conferring with teacher</p> <p>Choice of narrative or persuasive text composition</p> <p>Differentiated checklists and rubrics (if appropriate)</p> <p>Student selected goals for writing</p> <p>Level of independence</p> <p>Craft additional leads and endings for mentor texts</p> <p>Consult mentor texts to support writing</p> <p>ELL Supports and Extension activities are included with each lesson</p> <p><a href="#">Differentiation Strategies for Special Education Students</a></p> <p><a href="#">Differentiation Strategies for Gifted and Talented Students</a></p> <p><a href="#">Differentiation Strategies for ELL Students</a></p> <p><a href="#">Differentiation Strategies for At Risk Students</a></p>
<p><b>Resources</b></p>	
	<ul style="list-style-type: none"> <li>• What is engineering? <a href="https://www.youtube.com/watch?v=FAJGx3zP-Eo">https://www.youtube.com/watch?v=FAJGx3zP-Eo</a></li> <li>• Design squad introduces the design process: <a href="https://web.kamihq.com/web/viewer.html?source=extension_pdfhandler&amp;file=http%3A%2F%2Fwww-t.c.pbskids.org%2Fdesignsquad%2Fpdf%2Fparentseducators%2FDS_TG_full.pdf">https://web.kamihq.com/web/viewer.html?source=extension_pdfhandler&amp;file=http%3A%2F%2Fwww-t.c.pbskids.org%2Fdesignsquad%2Fpdf%2Fparentseducators%2FDS_TG_full.pdf</a></li> <li>• Website for videos by design squad for introducing the design process (on the bottom click to advance to the next step): <a href="http://pbskids.org/designsquad/parentseducators/workshop/process_id.html">http://pbskids.org/designsquad/parentseducators/workshop/process_id.html</a></li> <li>• Workshop notepad to record findings on design process introduction with videos: <a href="https://web.kamihq.com/web/viewer.html?source=extension_pdfhandler&amp;file=http%3A%2F%2Fpbskids.org%2Fdesignsquad%2Fpdf%2Fparentseducators%2Fworkshop%2Fworkshop_notepad.pdf">https://web.kamihq.com/web/viewer.html?source=extension_pdfhandler&amp;file=http%3A%2F%2Fpbskids.org%2Fdesignsquad%2Fpdf%2Fparentseducators%2Fworkshop%2Fworkshop_notepad.pdf</a></li> <li>• Toxic Popcorn design challenge: <a href="https://drive.google.com/drive/u/0/folders/1ol4M4n2cO97fecob3X0l0NGt5BhUm-qK?ogsrc=32">https://drive.google.com/drive/u/0/folders/1ol4M4n2cO97fecob3X0l0NGt5BhUm-qK?ogsrc=32</a></li> <li>• Egg Drop Design Challenge:<a href="https://www.teachengineering.org/activities/view/duk_consenergy_rde_act">https://www.teachengineering.org/activities/view/duk_consenergy_rde_act</a></li> <li>• Design loop: <a href="https://drive.google.com/file/d/1kk0hgSYF9fnR44uikFfeh96eQfcDf5Z/view?usp=sharing">https://drive.google.com/file/d/1kk0hgSYF9fnR44uikFfeh96eQfcDf5Z/view?usp=sharing</a></li> </ul>

# Wayne School District Curriculum Format

<b>Content Area/ Grade Level/ Course:</b>	Unit 2 Grade 6 STEM
<b>Unit Plan Title:</b>	Simple Machines/Newton's Laws
<b>Time Frame</b>	Six weeks

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- 8.2.8.ETW.4: Compare the environmental effects of two alternative technologies devised to address climate change issues and use data to justify which choice is best.
- 8.2.8.EC.1: Explain ethical issues that may arise from the use of new technologies.
- 8.2.8.EC.2: Examine the effects of ethical and unethical practices in product design and development.

## 2022 New Jersey Student Learning Standards for Science

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- **CROSS-CUTTING CONCEPT:** All human activity draws on natural resources and has both short- and long-term consequences, positive as well as negative, for the health of people and the natural environment.
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**MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.**

**MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.**

**MS-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.**

**MS-PS2-4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.**

**MS-PS2-5. Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.**

### Interdisciplinary Standards: New Jersey Student Learning Standards For English Language Arts Companion Standards Grade 6-8

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Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6-8 texts and topics*.

**NJSLS.ELA-LITERACY.RST.6-8.7**

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

### Unit Summary

Students are introduced to six simple machines—inclined plane, wedge, screw, lever, pulley, wheel-and-axle—as well as compound machines, which are combinations of two or more simple machines. Once students understand about work (work = force x distance), they become familiar with the machines' mechanical advantages, and see how they make work easier. Through an introduction to compound machines, students begin to think critically about machine inventions and their pervasive roles in our lives. Basic concepts involving Newton's Laws will help students have a better understanding of force and motion. They will expand on these concepts through completion of challenges involving these concepts such as Lego cars, catapults and playground equipment. After learning about Rube Goldberg contraptions—absurd inventions that complete simple tasks in complicated ways—they evaluate the importance and usefulness of the many machines around them. Through the hands-on activities, students will have various opportunities such as: draw designs for contraptions that could move a circus elephant into a railcar, create a construction site ramp design by measuring different inclined planes and calculating the ideal vs. actual mechanical advantage of each, catapult, creating a playground, compare the theoretical and actual mechanical advantages of different pulley systems conceived to save a whale, build and test grape catapults made with popsicle sticks and rubber bands, and follow the steps of the engineering design process to design and build Rube Goldberg machines.

The fundamental mechanical devices that have come to be known as "simple machines" through the years are basic human inventions that help accomplish physical tasks through mechanical advantage. The same simple machines used by ancient engineers to build pyramids are employed by today's engineers to construct modern structures such as houses, bridges, roller coasters and skyscrapers. From everyday hand tools (crowbars, nails, wheels, ramps) to intricate "compound machines" that marry together many simple machines in endless combinations (pencil sharpeners, bicycles, elevators, medical devices, airplanes), engineers of all types continually work together to design better and more creative tools, devices, equipment and products of modern convenience that help people do more with less, incorporating the principles of simple machines.

### Essential Question(s)

- What makes a question scientific?
- What constitutes evidence? When do you know you have enough evidence?
- Why is it necessary to justify and communicate an explanation?
- How can energy be transferred from one material to another? What happens to a material when energy is transferred to it?
- Where do you place the effort force and fulcrum in order to lift an object with the least amount of effort force.?
- How are levers used in daily life?
- What is the relationship between the effort force and the effort distance?
- How is a screw an example of an inclined plane?
- How do simple machines transfer energy?
- What is the amount of energy transferred by the simple machine equal to?
- Where do we see laws of motion in our daily lives and how can knowledge of those laws help us?
- How do forces influence motion?
- How can the principles of motion be put to use?
- How do we recognize different states of energy?
- How can we describe the position of an object?
- How does the mass of an object influence motion?

### Enduring Understandings

- Changes take place because of the transfer of energy. Energy is transferred to matter through the action of forces. Different forces are responsible for the transfer of the different forms of energy.
- The position of an object can be described by locating it relative to another object or to the background.
- Tracing and measuring an object's position over time can describe its motion.
- Speed describes how fast an object is moving.
- Energy may exist in two states: kinetic or potential.
- Kinetic energy is the energy of motion.

- A force is any push or pull that causes an object to move, stop, or change speed or direction.
- The greater the force, the greater the change in motion will be. The more massive an object, the less effect a given force will have on the object.
- Friction is the resistance to motion created by two objects moving against each other. Friction creates heat.
- Unless acted on by a force, objects in motion tend to stay in motion and objects at rest remain at rest.

**In this unit plan, the following 21<sup>st</sup> Century themes and skills are addressed.**

Check all that apply. <b>21<sup>st</sup> Century Themes</b>		Check all that apply. <b>21<sup>st</sup> Century Skills</b>	
<input checked="" type="checkbox"/>	<b>Global Awareness</b>	<input checked="" type="checkbox"/>	<b>Creativity and Innovation</b>
<input type="checkbox"/>	<b>Environmental Literacy</b>	<input checked="" type="checkbox"/>	<b>Critical Thinking and Problem Solving</b>
<input type="checkbox"/>	<b>Health Literacy</b>	<input checked="" type="checkbox"/>	<b>Communication</b>
<input type="checkbox"/>	<b>Civic Literacy</b>	<input checked="" type="checkbox"/>	<b>Collaboration</b>
<input checked="" type="checkbox"/>	<b>Financial, Economic, Business, and Entrepreneurial Literacy</b>		

**Student Learning Targets/Objectives (Students will know/Students will understand)**

- All simple machines operate on the fact that the input energy is equal to the output energy, but the effort force and effort distance are most likely different from the load/resistance force and load/resistance distance.
- The ratio (comparison) of load/resistance force to the effort force is called the mechanical advantage (MA).
- When using simple machines, the smaller the effort force, the larger the effort distance. This is an inverse relationship.
- The load is not an object, but a force. The “load” in a simple machine system is typically the weight of an object, but it can also be a resistance force such as the force of friction between a nail and a piece of wood.
- A lever is composed of three basic parts. They are the effort force, the load/resistance force, and the fulcrum.
- The placement of the fulcrum, effort force, and the load/resistance force determines the classification of the lever and more importantly how it can be used to transfer energy.
- A pulley can create an advantage to the user simply by changing the direction of the effort force and it may or may not also provide a mechanical advantage as well.
- An inclined plane can also provide a mechanical advantage to its user. The longer the inclined plane, the smaller the effort force needed to move the object up the inclined plane.
- A screw is actually an inclined plane wrapped around an axis.
- Conduct an investigation to collect evidence of the effects of balanced and unbalanced forces on the motion of a gravity-powered car.
- Design, build and test a safe gravity-powered car
- Collect and display in a table and line graph time and position data for a moving object.
- Explain that speed is a measure of motion.
- Interpret data to determine if the speed of an object is increasing, decreasing, or remaining the same.
- Identify the forces that cause an object’s motion.
- Describe the direction of an object’s motion: up, down, forward, backward.
- Infer that objects have kinetic energy.
- Design an investigation to determine the effect of friction on moving objects.

**Assessments (Pre, Formative, Summative, Other)**

**Denote required common assessments with an \***

Quizzes/Tests – Drawing race (identified in advantages of machines), vocabulary quiz on unit vocabulary, identify each of the simple machines, explain how they work, identify tools that use each of the simple machines, and identify how each reduces work.

Self-assessment of performance task

Activity embedded assessments

Teacher observation of student performance tasks for evidence of process and innovation.

\*Rubric of project design and completion

Journal writing

Round Robin Rube


*Drawing:* Have the students draw a picture of an existing or made-up compound machine, one that is made of two or three simple machines. Remind them to include where the force is applied and the machine's end function.

## Teaching and Learning Activities

<i>Activities</i>	<ul style="list-style-type: none"><li>● Curricular unit Simple Machines<ul style="list-style-type: none"><li>○ Advantages of Machines lesson</li><li>○ Simple solution for the circus</li><li>○ Tools and Equipment Part 1</li><li>○ Levers that Lift</li><li>○ Machines and Tools Part II</li><li>○ Not so Simple</li><li>○ The Magician's Catapult</li><li>○ Rube Goldberg and the Meaning of Machines</li><li>○ Design and Build a Rube Goldberg</li></ul></li><li>● Balloon Car STEM challenge</li><li>● Playground for Lego Figures</li><li>● Lego Car gravity powered vehicle</li></ul>
<i>Differentiation Strategies</i>	<p>Strategy and flexible groups based on formative assessment or student choice</p> <p>One:One conferring with teacher</p> <p>Choice of narrative or persuasive text composition</p> <p>Differentiated checklists and rubrics (if appropriate)</p> <p>Student selected goals for writing</p> <p>Level of independence</p> <p>Craft additional leads and endings for mentor texts</p> <p>Consult mentor texts to support writing</p> <p>ELL Supports and Extension activities are included with each lesson</p> <p><a href="#">Differentiation Strategies for Special Education Students</a></p> <p><a href="#">Differentiation Strategies for Gifted and Talented Students</a></p> <p><a href="#">Differentiation Strategies for ELL Students</a></p> <p><a href="#">Differentiation Strategies for At Risk Students</a></p>

## Resources

- Curricular unit Simple Machines:  
[https://www.teachengineering.org/curricularunits/view/cub\\_simp\\_machines\\_curricularunit](https://www.teachengineering.org/curricularunits/view/cub_simp_machines_curricularunit)
  - Advantages of Machines lesson:  
[https://www.teachengineering.org/lessons/view/cub\\_simp\\_machines\\_lesson01](https://www.teachengineering.org/lessons/view/cub_simp_machines_lesson01)
  - Simple solution for the circus:  
[https://www.teachengineering.org/activities/view/cub\\_simp\\_machines\\_lesson01\\_activity1](https://www.teachengineering.org/activities/view/cub_simp_machines_lesson01_activity1)
  - Tools and Equipment Part 1:  
[https://www.teachengineering.org/activities/view/cub\\_simp\\_machines\\_lesson02\\_activity1](https://www.teachengineering.org/activities/view/cub_simp_machines_lesson02_activity1)
  - Levers that Lift: [https://www.teachengineering.org/lessons/view/cub\\_simp\\_machines\\_lesson03](https://www.teachengineering.org/lessons/view/cub_simp_machines_lesson03)
  - Machines and Tools Part II:  
[https://www.teachengineering.org/activities/view/cub\\_simp\\_machines\\_lesson03\\_activity1](https://www.teachengineering.org/activities/view/cub_simp_machines_lesson03_activity1)
  - Not so Simple: [https://www.teachengineering.org/lessons/view/cub\\_simp\\_machines\\_lesson04](https://www.teachengineering.org/lessons/view/cub_simp_machines_lesson04)

- The Magician's Catapult:  
[https://www.teachengineering.org/activities/view/cub\\_simp\\_machines\\_lesson04\\_activity1](https://www.teachengineering.org/activities/view/cub_simp_machines_lesson04_activity1)
- Rube Goldberg and the Meaning of Machines:  
[https://www.teachengineering.org/lessons/view/cub\\_simp\\_machines\\_lesson05](https://www.teachengineering.org/lessons/view/cub_simp_machines_lesson05)
- Design and Build a Rube Goldberg:  
[https://www.teachengineering.org/activities/view/cub\\_simp\\_machines\\_lesson05\\_activity1](https://www.teachengineering.org/activities/view/cub_simp_machines_lesson05_activity1)
- Balloon Car STEM challenge (wheel and axle):  
<https://stemactivitiesforkids.com/2016/02/22/the-engineering-design-process/>
- Basic information for simple machines and resource sheets  
<https://drive.google.com/open?id=1rjcQIezUeVqd5G0H78rE0acibuKou7A4>
- Lego Masters - Episode 6 - Need for Speed
- [What Are Newton's Laws? - Unit - TeachEngineering](#)
- Ok Go- Rube Goldberg- <https://youtu.be/qybUFnY7Y8w>
- Playground-  Copy of Simple Machines Playground

## Wayne School District Curriculum Format

<b>Content Area/ Grade Level/ Course:</b>	Unit 3 Grade 6 STEM
<b>Unit Plan Title:</b>	Quick builds
<b>Time Frame</b>	Two weeks
<b>2020 New Jersey Student Learning Standards – Computer Science and Design Thinking</b>	
<ul style="list-style-type: none"> <li>8.2.8.ED.1: Evaluate the function, value, and aesthetics of a technological product or system, from the perspective of the user and the producer.</li> <li>8.2.8.ED.2: Identify the steps in the design process that could be used to solve a problem.</li> <li>8.2.8.ED.3: Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).</li> <li>8.2.8.ED.4: Investigate a malfunctioning system, identify its impact, and explain the step-by-step process used to troubleshoot, evaluate, and test options to repair the product in a collaborative team.</li> <li>8.2.8.ED.5: Explain the need for optimization in a design process.</li> <li>8.2.8.ED.6: Analyze how trade-offs can impact the design of a product.</li> <li>8.2.8.ED.7: Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches).</li> <li>8.2.8.ETW.1: Illustrate how a product is upcycled into a new product and analyze the short- and long-term benefits and costs.</li> <li>8.2.8.ETW.2: Analyze the impact of modifying resources in a product or system (e.g., materials, energy, information, time, tools, people, capital).</li> <li>8.2.8.ETW.3: Analyze the design of a product that negatively impacts the environment or society and develop possible solutions to lessen its impact.</li> <li>8.2.8.ETW.4: Compare the environmental effects of two alternative technologies devised to address climate change issues and use data to justify which choice is best.</li> <li>8.2.8.EC.1: Explain ethical issues that may arise from the use of new technologies.</li> <li>8.2.8.EC.2: Examine the effects of ethical and unethical practices in product design and development.</li> </ul>	
<b>2022 New Jersey Student Learning Standards for Science</b>	
<ul style="list-style-type: none"> <li><b>MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.</b></li> <li><b>MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.</b> <ul style="list-style-type: none"> <li><i><b>DCI:</b> The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful.</i></li> <li><i><b>PRACTICE:</b> Define a problem that can be solved through the development of an object, tool, process, or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.</i></li> <li><i><b>CROSS-CUTTING CONCEPT:</b> All human activity draws on natural resources and has both short- and long-term consequences, positive as well as negative, for the health of people and the natural environment.</i></li> </ul> </li> </ul>	

- **CROSS-CUTTING CONCEPT:** *The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.*
- **MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.**
  - **DCI:** *There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.*
  - **PRACTICE:** *Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.*
- **MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.**
  - **DCI:** *Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process--that is, some of those characteristics may be incorporated into the new design.*
  - **PRACTICE:** *Analyze and interpret data to determine similarities and differences in findings.*
- **MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.**
  - **DCI:** *The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.*
  - **PRACTICE:** *Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.*

**MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.**

**MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.**

**MS-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.**

**MS-PS2-4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.**

**MS-PS2-5. Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.**

### **Interdisciplinary Standards: New Jersey Student Learning Standards For English Language Arts Companion Standards Grade 6-8**

**NJSLS.ELA-LITERACY.RST.6-8.4**

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6-8 texts and topics*.

**NJSLS.ELA-LITERACY.RST.6-8.7**

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

### **Unit Summary**

Students will be given the opportunity to work individually and as a team on various quick challenges. Most of these quick builds will be a one day exploration of a topic. These quick builds will be spread throughout the marking period for students to explore various strategies with solving problems on a small scale. Students may not go all the way through the engineering design process, instead they will be given a challenge and quickly "draft" a design to build. Working together, problem-solving, and planning to come up with solutions encourages interaction and cooperation with peers.

## Essential Question(s)

- Why do we use parts of the engineering design process to solve quick build design challenges?
- How can parts of the engineering design process benefit us in solving problems in our daily lives?
- How can parts of the engineering design be used to create solutions to a problem?
- How is it possible to find several valid solutions to a single problem?
- Why is it a good idea to keep testing a design?
- What specific goal are you trying to achieve, and how will you know if you've been successful?
- How does the design meet the criteria for success presented in the challenge?
- How are science and engineering skills used to solve design problems?

## Enduring Understandings

- The Engineering Design Process is a method that is used to solve technological challenges to change and improve products for the way we live.
- The design process gives structure to creativity.
- The design loop allows engineers to find not “a” solution but the “best” solution to a problem.

In this unit plan, the following 21<sup>st</sup> Century themes and skills are addressed.

Check all that apply. 21 <sup>st</sup> Century Themes		Check all that apply. 21 <sup>st</sup> Century Skills	
<input checked="" type="checkbox"/>	Global Awareness	<input checked="" type="checkbox"/>	Creativity and Innovation
<input type="checkbox"/>	Environmental Literacy	<input checked="" type="checkbox"/>	Critical Thinking and Problem Solving
<input type="checkbox"/>	Health Literacy	<input checked="" type="checkbox"/>	Communication
<input checked="" type="checkbox"/>	Civic Literacy	<input checked="" type="checkbox"/>	Collaboration
<input checked="" type="checkbox"/>	Financial, Economic, Business, and Entrepreneurial Literacy		

## Student Learning Targets/Objectives (Students will know/Students will understand)

### Paper Planes

- Design at least two different paper airplanes.
- Modify one of their designed airplanes in an attempt to improve its flight.
- Become familiar with parts of a paper airplane and how they relate to parts on a real airplane.

### Stacking Cups

- Design a contraption that will assist in problem-solving
- Modify designs throughout the different challenges

### Origami

- Design a starshade shield using paper and folding techniques
- Design and Modify a package to hold a product using paper and folding techniques

### Paper Chain

- Design a paper chain using minimal materials while following the criteria and constraints
- Modify the paper chain to achieve the longest length using the engineering design process

### Keva Planks

- Design and Build a tower following specific criteria
- Modify the tower using the engineering design process
- Design and Build a wooden plank track that turns around 180 degrees and returns the ball back to you.

### Paper Tower

- Design and build the tallest paper tower that will hold an object at the top
- Modify the design using the engineering design process

### Card Sort

- Identify and Solve a problem using team building techniques
- Sort cards in multiple ways while working as a team with and without verbal communication

### Hoop Gliders

- Design and build a glider to travel the furthest distance by changing different variables
- Modify design using the engineering design process

### Index Card Common Interests

- Build a tower using index cards with common interests throughout the group
- Modify designs using engineering design process

### Recyclable Boats

- Design and Build a boat using various materials that will meet specific criteria over several challenges
- Modify boat designs using the engineering design process

## Assessments (Pre, Formative, Summative, Other)

*Denote required common assessments with an \**

### Quizzes/Tests – Vocabulary

\*Self-assessment of performance task

\*Teacher observation of student performance tasks for evidence of process and innovation.

\*Group presentation content should demonstrate: a representative abstract description, an adequate graphic representation, descriptive introduction that describes (at minimum) the following: What type of product the invention relates to, how it combines two or more objects, a brief description of when, where, or how this invention would be used, an answer to the question that describes how the new invention creates an improvement for the target audience.

## Teaching and Learning Activities

### *Activities*

- Paper Airplane
- Paper Chain
- Strongest paper tower
- Tallest tower (paper, pipe cleaners)
- Origami/ tangrams
- Solo cup stacking
- Hoop gliders
- Paper boats
- Playing cards sort
- Common interest index card tower
- STEM Improv

<p><i>Differentiation Strategies</i></p>	<p>Strategy and flexible groups based on formative assessment or student choice</p> <p>One:One conferring with teacher</p> <p>Choice of narrative or persuasive text composition</p> <p>Differentiated checklists and rubrics (if appropriate)</p> <p>Student selected goals for writing</p> <p>Level of independence</p> <p>Craft additional leads and endings for mentor texts</p> <p>Consult mentor texts to support writing</p> <p>ELL Supports and Extension activities are included with each lesson</p> <p><a href="#">Differentiation Strategies for Special Education Students</a></p> <p><a href="#">Differentiation Strategies for Gifted and Talented Students</a></p> <p><a href="#">Differentiation Strategies for ELL Students</a></p> <p><a href="#">Differentiation Strategies for At Risk Students</a></p>
<p><b>Resources</b></p>	
<p>Nasa &amp; Origami <a href="https://www.jpl.nasa.gov/edu/learn/project/space-origami-make-your-own-starshade/">https://www.jpl.nasa.gov/edu/learn/project/space-origami-make-your-own-starshade/</a></p> <p>Paper Airplane <a href="#">Science Buddies Paper Airplane</a></p> <p>Hoop Glider <a href="https://www.alcosan.org/educational-activities/parent-resources/hoop-glider-challenge">https://www.alcosan.org/educational-activities/parent-resources/hoop-glider-challenge</a></p> <p>Paper Chain <a href="https://www.extension.iastate.edu/greene/files/documents/paper-chain-challenge.pdf">https://www.extension.iastate.edu/greene/files/documents/paper-chain-challenge.pdf</a></p> <p>Paper Tower <a href="https://www.sciencebuddies.org/science-fair-projects/project-ideas/CE_p027/civil-engineering/tallest-paper-tower-challenge">https://www.sciencebuddies.org/science-fair-projects/project-ideas/CE_p027/civil-engineering/tallest-paper-tower-challenge</a></p> <p>Pipe Cleaner tower <a href="https://www.vivifysystem.com/blog/2014/12/8/pipecleaner-stem-challenge">https://www.vivifysystem.com/blog/2014/12/8/pipecleaner-stem-challenge</a></p> <p>Paper boats <a href="https://docs.google.com/document/d/1VpWgvoqGcDgfSCAsfh9ACVTYsTiQjKW-eISDfhacO60/edit?usp=sharing">https://docs.google.com/document/d/1VpWgvoqGcDgfSCAsfh9ACVTYsTiQjKW-eISDfhacO60/edit?usp=sharing</a></p> <p>Playing cards sort <a href="https://drive.google.com/drive/folders/1E5f0H0--Oxhzd1lz5MVb4bwqv0Wk8OV?usp=drive_link">https://drive.google.com/drive/folders/1E5f0H0--Oxhzd1lz5MVb4bwqv0Wk8OV?usp=drive_link</a></p> <p>Common Interest Index Card Challenge: <a href="https://teachersareterrific.com/2017/03/index-card-towers.html">https://teachersareterrific.com/2017/03/index-card-towers.html</a> <a href="https://www.educationworld.com/a_lesson/encouraging-cooperation-group-activity.shtml">https://www.educationworld.com/a_lesson/encouraging-cooperation-group-activity.shtml</a></p> <p>STEM improv: <a href="https://youtu.be/c6-6ol4CccM">https://youtu.be/c6-6ol4CccM</a></p>	