Randolph Township Schools
Randolph Middle School
Technology Challenges Curriculum

"Successful engineering is all about understanding how things break or fail"
-Henry Petroski

STEM Department
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September 21, 2021

Randolph Township Schools
Randolph Middle School
Technology Challenges Curriculum

Table of Contents

Section

Randolph Township Schools
Randolph Middle School
Technology Challenges Curriculum

Mission Statement

We commit to inspiring and empowering all students in Randolph schools to reach their full potential as unique, responsible and educated members of a global society.

Affirmative Action Statement
Equality and Equity in Curriculum

The Randolph Township School district ensures that the district's curriculum and instruction are aligned to the state's standards. The curriculum provides equity in instruction, educational programs and provides all students the opportunity to interact positively with others regardless of race, creed, color, national origin, ancestry, age, marital status, affectional or sexual orientation, gender, religion, disability or socioeconomic status.

N.J.A.C. 6A:7-1.7(b): Section 504, Rehabilitation Act of 1973; N.J.S.A. 10:5; Title IX, Education Amendments of 1972

Randolph Township Schools
Randolph Middle School
Technology Challenges Curriculum

EDUCATIONAL GOALS
VALUES IN EDUCATION

The statements represent the beliefs and values regarding our educational system. Education is the key to self-actualization, which is realized through achievement and self-respect. We believe our entire system must not only represent these values, but also demonstrate them in all that we do as a school system.

We believe:

- The needs of the child come first
- Mutual respect and trust are the cornerstones of a learning community
- The learning community consists of students, educators, parents, administrators, educational support personnel, the community and Board of Education members
- A successful learning community communicates honestly and openly in a non-threatening environment
- Members of our learning community have different needs at different times. There is openness to the challenge of meeting those needs in professional and supportive ways
- Assessment of professionals (i.e., educators, administrators and educational support personnel) is a dynamic process that requires review and revision based on evolving research, practices and experiences
- Development of desired capabilities comes in stages and is achieved through hard work, reflection and ongoing growth

Randolph Township Schools
Randolph Middle School
Technology Challenges Curriculum

Introduction

This is a marking period cycle course offered to seventh grade students interested in technology and engineering. This course focuses heavily on the concept of simple machines and how they can assist us with tasks in our everyday lives. Technology Challenges includes hands-on activities that are centered on the different forms of simple machines: pulleys, levers, wheels, screws, inclined planes, and wedges. Through these activities, students will develop and apply problem solving, creativity, and technological skills to develop real-world solutions. By the end of this course, students will gain a fundamental understanding of simple machines and how they can be used simultaneously to form compound machines that benefit our society. This course will be guided by the current New Jersey Learning Standards in Computer Science and Design Thinking, Career Readiness, Life Literacies, and Key Skills, Science, Mathematics, and English.

Randolph Township Schools
Randolph Middle School
Technology Challenges Curriculum

Curriculum Pacing Chart

SUGGESTED TIME ALLOTMENT	UNIT NUMBER	CONTENT - UNIT OF STUDY
7 weeks	**I**	**Engineering with Simple Machines**
2 weeks	**II**	**Rube Goldberg Machines**

Randolph Township Schools
Randolph Middle School
Technology Challenges Curriculum

Unit I: Engineering with Simple Machines

<table>
<tr><td colspan="3">TRANSFER: Students will be able to mobilize the engineering design process and domain knowledge to create an original model given limitations and constraints.</td></tr>
<tr><td>STANDARDS / GOALS:</td><td>ENDURING UNDERSTANDINGS</td><td>ESSENTIAL QUESTIONS</td></tr>
<tr><td rowspan="5">NJ 2020 SLS: 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.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).</td><td>Work is a quantity that measures a force acting on an object over a distance.

Simple machines provide a mechanical advantage to our everyday tasks.</td><td>• How are machines organized to do work?

• How have simple machines affected the development of human civilizations?</td></tr>
<tr><td><u>KNOWLEDGE</u>
Students will know:</td><td><u>SKILLS</u>
Students will be able to:</td></tr>
<tr><td>A simple machine is a mechanical device that changes the direction or magnitude of a force.</td><td>Identify various simple machines (pulleys, levers, wheels, inclined planes, wedges, screws) and explain their functionality.</td></tr>
<tr><td>Work can be calculated by measuring the amount of Newton’s used to move an object over a specific distance.</td><td>Identify measuring tools (spring scale, meter stick, etc.) needed to conduct an experiment for calculating the amount of scientific work.</td></tr>
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Randolph Township Schools
Randolph Middle School
Technology Challenges Curriculum

Unit I: Engineering with Simple Machines

8.2.8.ITH.2: Compare how technologies have influenced society over time. 8.2.8.ITH.5: Compare the impacts of a given technology on different societies, noting factors that may make a technology appropriate and sustainable in one society but not in another. 8.2.8.NT.1: Examine a malfunctioning tool, product, or system and propose solutions to the problem. 8.2.8.ETW.3: Analyze the impact of modifying resources in a product or system (e.g., materials, energy, information, time, tools, people, capital). **NJ 2020 SLS: Career Readiness, Life Literacies, and Key Skills** 9.4.8.CI.2: Repurpose an existing resource in an innovative way.	Pulleys are wheels with a grooved rim around its edge for holding a rope or cable. A system of pulleys may be used to improve advantage in lifting weights, thereby reducing the force required to move an object. A lever is a beam or rigid rod pivoted at a fixed point or fulcrum. The position of the fulcrum on the lever can determine the amount of force needed to move an object.	Compare and contrast various pulley sizes. Design a product that uses multiple pulleys to function efficiently. Construct a pulley system that successfully performs a given task within project constraints. Research various types of levers. Evaluate various lever prototypes. Compare and contrast the different lever classes. Incorporate various woodworking and crafting tools around the technology classroom to design a lever that can launch a small object a desired distance

Randolph Township Schools
Randolph Middle School
Technology Challenges Curriculum

Unit I: Engineering with Simple Machines

NJ 2020 SLS: Science MS-ETS1-4 Develop a model to generate data for iterative testing and modifications of a proposed object, tool, or process such that an optimal design can be achieved.		Reframe engineering failures into positive results. Construct a functioning lever.
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 an the mass of the object.	Wheels help you move an object by limiting the amount of friction and working as levers.	Research various wheel materials for determining which wheels increase traction and reduce friction.
MS-PS3-2 Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.	An axle is a central shaft for a rotating wheel.	Evaluate vehicle prototypes for axle positioning as it relates to speed and aerodynamic abilities.
MS-PS3-5 Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from an object.		Design and construct a vehicle that functions within specific project constraints.
	An inclined plane is a ramp and works by helping lift things more easily up to a higher level.	Investigate the designs of various inclined plane.
	A wedge helps you push things apart or hold things in place.	Examine how wedges compare to inclined planes. Analyze various uses for the wedge.

Randolph Township Schools
Randolph Middle School
Technology Challenges Curriculum

Unit I: Engineering with Simple Machines

NJ 2016 SLS: Literacy in History, Social Studies, & Technical Subjects 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). **NJ 2020 SLS: Science: Crosscutting Statements 6-8** • Cause and effect • Structure and function • Systems and system models **NJ 2020 SLS: Science: Science and Engineering Practices 6-8** • Asking questions and defining problems • Developing and using models • Planning and carrying out investigations • Analyzing and interpreting data **NJ 2020 SLS: Science: Disciplinary Core Ideas 6-8** • Developing Possible Solutions • Developing and Using Models	Screws are inclined planes wrapped around a cylinder. **VOCABULARY:** Procedures, analysis, resources, researching, brainstorming, developing, building, testing, reflection, criteria, constraints **KEY TERMS:** Work, mechanical advantage, leverage, friction, fulcrum, trebuchet, gears, inclined plane, wedge, lever, pitch, screwdriver	Compare and contrast screws, inclined planes, and wedges. Construct a model screw using classroom items.

Randolph Township Schools
Randolph Middle School
Technology Challenges Curriculum

Unit I: Engineering with Simple Machines

Mathematical Practices **MP4** Model with mathematics **MP5** Use appropriate tools strategically		

ASSESSMENT EVIDENCE: Students will show their learning by:

- Calculating the amount of work that is used to pull various objects around the room
- Planning multiple project proposals to communicate ideas
- Constructing and evaluating a product that utilizes an efficient pulley system
- Constructing and evaluating a functioning lever
- Constructing and evaluating a vehicle that incorporates effective wheels
- Constructing and evaluating a paper screw

KEY LEARNING EVENTS AND INSTRUCTION:

- Students will engage in small group collaboration (planning, analyzing constraints, and constructing)
- Students will produce technical drafts
- Students will develop models of constructed designs
- Students will reflect daily in engineering journals

Randolph Township Schools
Randolph Middle School
Technology Challenges Curriculum

Unit I: Engineering with Simple Machines

SUGGESTED TIME ALLOTMENT	**7 weeks**
SUPPLEMENTAL UNIT RESOURCES	<u>Required Supplies/Activities/Software:</u> Computers "Scientific Work Experiment" "Elevator Control" "Trebuchet Toss" "Ferrari Design" "Building a Screw" <u>Suggested Supplies/Activities/Software:</u> Various woodworking and crafting tools Measuring and drafting tools Craft Sticks Balsa Wood String/Yarn Pulleys Dowels Cardboard Paper Clips Various wheel materials Other scrap material

Randolph Township Schools
Randolph Middle School
Technology Challenges Curriculum

Unit II: Rube Goldberg Machines

<table>
<tr><td colspan="3">TRANSFER: Students will be able to mobilize the engineering design process and domain knowledge to create an original model given limitations and constraints.</td></tr>
<tr><td rowspan="4">STANDARDS / GOALS:
NJ 2020 SLS: Computer Science and Design Thinking
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.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 sketched).

8.2.8.NT.3: Examine a system, consider how each part relates to other parts and redesign it for another purpose.</td><td>ENDURING UNDERSTANDINGS</td><td>ESSENTIAL QUESTIONS</td></tr>
<tr><td>The engineering design process provides structure to creativity.

Combining multiple simple machines to form one larger machine can enhance productivity and efficiency.</td><td>• How the engineering design process relates to problem solving and critical thinking?

• How does production efficiency effect the overall success or failure of an invention?</td></tr>
<tr><td><u>KNOWLEDGE</u>
Students will know:</td><td><u>SKILLS</u>
Students will be able to:</td></tr>
<tr><td>A Rube Goldberg Machine is a complicated device built to perform a simple task.

A Rube Goldberg often puts objects through a “cause and effect” trial.</td><td>Research the design and construction of various Rube Goldberg.

Establish small teams to brainstorm and plan project proposals.</td></tr>
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Randolph Township Schools
Randolph Middle School
Technology Challenges Curriculum

Unit II: Rube Goldberg Machines

NJ 2020 SLS: Career Readiness, Life Literacies, and Key Skills 9.4.8.CI.2: Repurpose an existing resource in an innovative way. **NJ 2020 SLS: Science** 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. MS-ETS1-2 Evaluate competing design solutions using a systemic process to determine how well they meet the criteria and constraints of the problem. 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.	Multiple simple machines are used in every Rube Goldberg. Evaluation of a finished product helps determine its overall success. **VOCABULARY:** Specifications, researching, brainstorming, developing, building, testing, reflection, criteria, constraints, analyze **KEY TERMS:** Rube Goldberg Machine, contraption, cause and effect	Produce a detailed proposal that outlines the various steps for an innovative Rube Goldberg Machine within given criteria and constraints. Distinguish which simple machines will best fit their own Rube Goldberg machines plans. Construct a functioning Rube Goldberg Machine that successful solves an existing problem. Evaluate competing Rube Goldberg solutions to determine how well they meet the criteria and constraints.

Randolph Township Schools
Randolph Middle School
Technology Challenges Curriculum

Unit II: Rube Goldberg Machines

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-PS3-2 Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. MS-PS3-5 Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from objects. **NJ 2016 SLS: Literacy in History, Social Studies, & Technical Subjects** 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). **NJ 2020 SLS: Science: Crosscutting Statements 6-8** • Cause and effect • Structure and function		

Randolph Township Schools
Randolph Middle School
Technology Challenges Curriculum

Unit II: Rube Goldberg Machines

• Systems and system models **NJ 2020 SLS: Science: Science and Engineering Practices 6-8** • Asking questions and defining problems • Developing and using models • Planning and carrying out investigations. **NJ 2020 SLS: Science: Disciplinary Core Ideas 6-8** • Developing Possible Solutions • Developing and Using Models **Mathematical Practices** **MP5** Use appropriate tools strategically.		

ASSESSMENT EVIDENCE: Students will show their learning by:

- Planning a detailed project proposal
- Constructing a multi-step Rube Goldberg Machine that completes a task within given criteria and constraints
- Evaluating and reflecting on original design and peer prototypes

Randolph Township Schools
Randolph Middle School
Technology Challenges Curriculum

Unit II: Rube Goldberg Machines

KEY LEARNING EVENTS AND INSTRUCTION:

- Students will engage in small group collaboration (planning, analyzing constraints, and constructing)
- Students will produce technical drafts
- Students will develop models of constructed designs
- Students will reflect daily in engineering journals

Randolph Township Schools
Randolph Middle School
Technology Challenges Curriculum

Unit II: Rube Goldberg Machines

SUGGESTED TIME ALLOTMENT	**2 weeks**
SUPPLEMENTAL UNIT RESOURCES	Required Supplies/Activities/Software: Computers "Rube Goldberg Project Proposal" "Rube Goldberg Construction" Suggested Supplies/Activities/Software: Various woodworking and crafting tools Craft Sticks Balsa Wood String/Yarn Pulleys Dowels Cardboard Other scrap material