PRINCIPLES OF ENGINEERING Curriculum

This curricula and accompanying instructional materials have been developed to align with the NJSLS and in accordance with the NJ Department of Education's guidelines to include: Curriculum designed to meet grade level expectations, integrated accommodations and modifications for students with IEPs, 504s, ELLs, and gifted and talented students, assessments including benchmarks, formative, summative, and alternative assessments, a list of core instructional and supplemental materials, pacing guide, interdisciplinary connections, integration of 21st century skills, integration of technology, and integration of 21st Century Life and Career standards.

About the Standards

In 1996, the New Jersey State Board of Education adopted the state's first set of academic standards called the Core Curriculum Content Standards. The standards described what students should know and be able to do upon completion of a thirteen-year public school education. Over the last twenty years, New Jersey's academic standards have laid the foundation for local district curricula that is used by teachers in their daily lesson plans.

Revised every five years, the standards provide local school districts with clear and specific benchmarks for student achievement in nine content areas. Developed and reviewed by panels of teachers, administrators, parents, students, and representatives from higher education, business, and the community, the standards are influenced by national standards, research-based practice, and student needs. The standards define a "Thorough and Efficient Education" as guaranteed in 1875 by the New Jersey Constitution. Currently the standards are designed to prepare our students for college and careers by emphasizing high-level skills needed for tomorrow's world.

The New Jersey Student Learning Standards include Preschool Teaching and Learning Standards, as well as nine K-12 standards for the following content areas: **21st Century Life and Careers, Comprehensive Health and Physical Education, English Language Arts, Mathematics, Science, Social Studies, Technology, Visual and Performing Arts, World Languages**

Lower Cape May Regional Principles of Engineering Curriculum	
Content Area: Engineering	
Course Title: Principles of Engineering	**Grade level: 10-12**
Unit 1: Energy and Power	**Dates for Units: Marking Period 1**
Unit 2: Materials and Structures	**Date for Unit: Marking Period 2**
Unit 3: Control Systems	**Dates for Units: Marking Period 3**
Unit 4: Statistics & Kinematics	**Dates for Units: Marking Period 4**
Date Created: 9-1-17	**Board Approved On:**

Lower Cape May Regional Principles of Engineering Curriculum Unit 1 Overview
Content Area: Engineering
Unit Title: Energy and Power

Target Course/Grade Level: Principles of Engineering / 10-12

Unit Summary:
In this unit students will be able to distinguish between the six simple machines, their attributes, and components. Students will additionally be able to calculate mechanical advantage and drive ratios of mechanisms and determine efficiency in a mechanical system. Students will also be able to explain the advantages and disadvantages of nonrenewable, renewable, and inexhaustible energy sources. The relationship between resistance, current, and voltage within an electrical circuit and calculations based on Ohm's Law will be presented. Students will further expand upon the relationship between work, energy, and power. The process of producing electricity utilizing a solar hydrogen system as well as explaining thermal energy transfer through materials will also be discussed.

Interdisciplinary Connections: **Link to NJSLS**

- In addition to Technology standards, connections are linked to the New Jersey Student Learning Standards in Mathematics and Science.
- **NJSLS PS3.A: Definitions of Energy - Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.** Students Identify and categorize energy sources as nonrenewable, renewable, or inexhaustible. .They will then create and deliver a presentation to explain a specific energy source.
- **NJSLS PS3.A: Definitions of Energy. "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents.** Students will create a hydrogen fuel cell/solar powered vehicle. Students will also use circuit simulation software and complete calculations based on ohm's law.
- **NJSLS PS3.B: Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.** Using thermodynamics, students will design, construct, and test recyclable insulation materials. Additionally, students will test and apply the relationship between R-values and the recyclable insulation by using a thermodynamics heat box.

Resources: Effective Strategies for Interdisciplinary Teaching

Integration of 21st Century Skills.

- **CRP1-**Students will act as responsible and contributing citizens*
- **CRP2-**Students will apply applicable academic skills*
- **CRP3-**Students will attend to personal health and financial well-being
- **CRP4-**Students will communicate effectively, clearly and with reason*
- **CRP5-**Students will consider the environmental, social, and economic impacts of decisions*
- **CRP6-**Students will demonstrate creativity and innovation*

- **CRP7**-Students will employ valid and reliable research strategies*
- **CRP8**-Students will utilize critical thinking to make sense of problems and persevere in solving* them
- **CRP9**-Students will model leadership, integrity, and effective management*
- **CRP10**-Students will plan education and career paths aligned to personal goals*
- **CRP11**-Students will utilize technology to enhance productivity*
- **CRP12**-Students will work productively in teams while using cultural, global competence*

For more information regarding 21st Century Skills and for classroom resources click here.

Integration of Technology Standards

- **Standard 8.1 Computer Science:** This outlines a comprehensive set of concepts and skills, such as data and analysis, algorithms and programming, and computing systems.
- **Standard 8.2 Design Thinking:** This outlines the technological design concepts and skills essential for technological and engineering literacy. The framework design includes Engineering Design, Ethics and Culture, and the Effects of Technology on the Natural world among the disciplinary concepts.

For more information regarding Technology Standards click here.

Integration of 21st Century Life and Career Standards

- **9.1 Personal Financial Literacy:** Students will understand the important fiscal knowledge, habits, and skills that must be mastered in order to make informed decisions about personal finance. Financial literacy is an integral component of a student's college and career readiness, enabling students to achieve fulfilling, financially-secure, and successful careers.

- **9.2 Career Awareness, Exploration, and Preparation:** Students will understand the importance of being knowledgeable about one's interests and talents, and being well informed about postsecondary and career options, career planning, and career requirements.*

- **9.3 Career and Technical Education:** Students will know and understand the expectations aligned with the completion of a CTE Program of Study.*
  9.3.ST.4, 9.3.ST.5, 9.3.ST-ET.4, 9.3.ST-ET.5

For more information regarding 21st Century Life and Career Standards click here.

Learning Targets

Performance Expectation #	**Performance Expectation for Unit** **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 modifications to increase optimization based on feedback.

8.2.12.ED.4	Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.
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).
9.2.12.C.1	Review career goals and determine steps necessary for attainment.

Resource Link

Unit Enduring Questions:

- Why is it important to begin considering career paths during high school?
- What career opportunities are available to match your specific interests?
- What are some current applications of simple machines, gears, pulleys, and sprockets?
- What are some strategies that can be used to make everyday mechanisms more efficient?
- What are the trade-offs of mechanical advantage related to design?
- Why must efficiency be calculated and understood during the design process**?**
- What sources of energy are available for use? What are the benefits and drawbacks regarding efficiency, usefulness, and the environment?
- What is the relationship between resistance, current, and voltage within an electrical system?

Unit Enduring Understandings:

- Engineers and engineering technologists apply math, science, and discipline-specific skills to solve problems.
- Most mechanisms are composed of gears, sprockets, pulley systems, and simple machines.
- Mechanisms are used to redirect energy within a system by manipulating force, speed, and distance.
- Mechanical advantage ratios mathematically evaluate input work versus output work of mechanisms.
- Energy source classifications include nonrenewable, renewable, and inexhaustible.
- Energy source processes include harnessing, storing, transporting, and converting.
- Energy often needs to be converted from one form to another to meet the needs of a given system.
- An understanding of work, energy, and power is required to determine system efficiency.
- An understanding of the basics of electricity requires the understanding of the three fundamental concepts of voltage, current, and resistance.
- The atomic structure of a material determines whether it is a conductor, an insulator, or a semiconductor.
- Energy management is focused on efficient and accessible energy use.
- System energy requirements must be understood in order to select the proper energy source.
- Energy systems can include multiple energy sources that can be combined to convert energy into useful forms.

• What is the distinguishing characteristics between series and parallel circuits? • What limitations affect electricity production using solar cells? • What limitations affect electricity production using hydrogen fuel cells? • How can system configuration affect voltage and current? • How does thermodynamics relate to energy and power? • What are some everyday examples of the First and Second Laws of Thermodynamics?	• Hydrogen fuel cells create electricity and heat through an electrochemical process that converts hydrogen and oxygen into water. • Solar cells convert light energy into electricity by using photons to create electron flow. • Thermodynamics is the study of the effects of work, thermo energy, and energy on a system. • Thermal energy can transfer via convection, conduction, or radiation. • Material conductivity, resistance, and energy transfer can be calculated.
Unit Objectives: ***Students will know….*** • The difference between engineering and engineering technology. • The relationship between work and power in a mechanical system. • The processes of calculating mechanical advantage. • The advantages and disadvantages of nonrenewable, renewable, and inexhaustible energy sources. • The relationship between resistance, current, and voltage within an electrical circuit. • The relationship between work, energy, and power. • The process of producing electricity utilizing a solar hydrogen system. • Thermal energy transfer through material. • The relationship between voltage, current, and wattage.	**Unit Objectives:** ***Students will be able to…...*** • Differentiate between engineering and engineering technology. • Identify and differentiate among different engineering disciplines. • Measure forces and distances related to mechanisms. • Distinguish between the six simple machines, their attributes, and components. • Calculate mechanical advantage and drive ratios of mechanisms. • Design, create, and test gear, pulley, and sprocket systems. • Calculate work and power in mechanical systems. • Determine efficiency in a mechanical system. • Identify and categorize energy sources as nonrenewable, renewable, or inexhaustible. • Create and deliver a presentation to explain a specific energy source. • Calculate work and power. • Demonstrate the correct use of a digital multimeter. • Calculate circuit resistance, current, and voltage using Ohm’s law. • Identify and explain the advantages and disadvantages of parallel and series circuit design in an application • Test and apply the relationship between voltage, current, and resistance relating to a photovoltaic cell and a hydrogen fuel cell.

	• Experiment with a solar hydrogen system to produce mechanical power. • Design, construct, and test recyclable insulation materials. • Test and apply the relationship between R-values and recyclable insulation. • Complete calculations for conduction, R-values, and radiation.

Lower Cape May Regional Principles of Engineering Curriculum **Unit 2 Overview**
Content Area: Engineering
Unit Title: Materials and Structures
Target Course/Grade Level: Principles of Engineering / 10-12
Unit Summary: In this unit students will explore and gain an understanding of the forces acting on a body in static equilibrium. Students will be able to create free body diagrams of objects, identifying all forces acting on the object. Additionally, students will be able to mathematically locate the centroid of structural members, calculate moment of inertia of structural members. Knowledge of the basic categories and properties of materials will also be discussed.
Interdisciplinary Connections: **Link to NJSLS** • In addition to Technology standards, connections are linked to the New Jersey Student Learning Standards in Mathematics. • **NJSLS Math N-VM.4: Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.** Students will use force vectors to solve for outside forces acting on trusses. • **NJSLS Math A-CED: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.** Students will rearrange the formula to solve for beam deflection in order to highlight modulus of elasticity. **Resources:** Effective Strategies for Interdisciplinary Teaching
Integration of 21st Century Skills (Choose all that apply by denoting an asterisk). • **CRP1**-Students will act as responsible and contributing citizens*

- **CRP2-**Students will apply applicable academic skills*
- **CRP3-**Students will attend to personal health and financial well-being
- **CRP4-**Students will communicate effectively, clearly and with reason*
- **CRP5-**Students will consider the environmental, social, and economic impacts of decisions*
- **CRP6-**Students will demonstrate creativity and innovation*
- **CRP7-**Students will employ valid and reliable research strategies*
- **CRP8-**Students will utilize critical thinking to make sense of problems and persevere in solving them*
- **CRP9-**Students will model leadership, integrity, and effective management*
- **CRP10-**Students will plan education and career paths aligned to personal goals*
- **CRP11-**Students will utilize technology to enhance productivity*
- **CRP12-**Students will work productively in teams while using cultural, global competence*

For more information regarding 21st Century Skills and for classroom resources click here.

Integration of Technology Standards

- **Standard 8.1 Computer Science:** This outlines a comprehensive set of concepts and skills, such as data and analysis, algorithms and programming, and computing systems.
- **Standard 8.2 Design Thinking:** This outlines the technological design concepts and skills essential for technological and engineering literacy. The framework design includes Engineering Design, Ethics and Culture, and the Effects of Technology on the Natural world among the disciplinary concepts.

For more information regarding Technology Standards click here.

Integration of 21st Century Life and Career Standards (Choose all that apply by denoting an asterisk).

- **9.1 Personal Financial Literacy:** Students will understand the important fiscal knowledge, habits, and skills that must be mastered in order to make informed decisions about personal finance. Financial literacy is an integral component of a student's college and career readiness, enabling students to achieve fulfilling, financially-secure, and successful careers.

- **9.2 Career Awareness, Exploration, and Preparation:** Students will understand the importance of being knowledgeable about one's interests and talents, and being well informed about postsecondary and career options, career planning, and career requirements.*

- **9.3 Career and Technical Education:** Students will know and understand the expectations aligned with the completion of a CTE Program of Study.
  9.3.ST.2, 9.3.ST.6, 9.3.ST-ET-3, 9.3.ST-ET.4, 9.3.ST-ET.5

For more information regarding 21st Century Life and Career Standards click here.

Learning Targets

Performance Expectation #	**Performance Expectation for Unit** **NJSLS Standards**

8.2.12.ED.2	Create scaled engineering drawings for a new product or system and make modifications 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.2	Redesign an existing product to improve form or function.

Unit Enduring Questions:

- Why is it crucial for designers and engineers to construct accurate free body diagrams of the parts and structures that they design?
- Why must designers and engineers calculate forces acting on bodies and structures?
- When solving truss forces, why is it important to know that the structure is statically determinate?
- How does an engineer predict the performance and safety for a selected material?
- What are the advantages and disadvantages of utilizing synthetic materials designed by engineers?
- What ethical issues pertain to engineers designing synthetic materials?
- What did you learn about the significance of selecting materials for product design?
- How can an existing product be changed to incorporate different processes to make it less expensive and provide better performance?
- How does an engineer decide which manufacturing process to use for a given material?

Unit Enduring Understandings:

- Laws of motion describe the interaction of forces acting on a body.
- Structural member properties including centroid location, moment of inertia, and modulus of elasticity are important considerations for structure design.
- Static equilibrium occurs when the sum of all forces acting on a body are equal to zero.
- Applied forces are vector quantities with a defined magnitude, direction, and sense, and can be broken into vector components.
- Forces acting at a distance from an axis or point attempt or cause an object to rotate.
- In a statically determinate truss, translational and rotational equilibrium equations can be used to calculate external and internal forces.
- Free body diagrams are used to illustrate and calculate forces acting upon a given body.
- Materials are the substances in which all things are made.
- Materials are composed of elements and area categorized by physical and chemical properties.
- Materials consist on pure elements, compounds and mixtures and are typically classified as metallic, ceramic, organic, polymeric, and composite.
- Material properties including recyclability and

● How do the recycling codes and symbols differ from state to state? ● Why is it critical for engineers to document all calculation steps when solving problems? ● How is material testing data useful? ● Stress strain curve date points are useful in determining what specific material properties?	cost are important considerations for engineers when choosing appropriate materials for a design. ● Material selection is based upon mechanical, thermal, electromagnetic, and chemical properties. ● Engineers utilize a design process and mathematical formulas to solve and document design problems. ● Material testing aids in determining a product's reliability, safety, and predictability in function. ● Engineers perform destructive and non-destructive tests on material specimens for the purpose of identifying and verifying the properties of various materials. ● Material testing provides a reproducible evaluation of material properties. ● Tensile testing data is used to create a test sample stress strain curve. ● Stress strain data points are used to identify and calculate sample material properties including elastic range, proportional limit, modulus of elasticity, elastic limit, resilience, yield point, plastic deformation, ultimate strength, failure, and ductility.
Unit Objectives: ***Students will know….*** ● The importance of free body diagrams. ● How loads are transmitted through a structure. ● How to calculate internal and external reaction forces relating to a structure ● T difference between the basic properties of materials, such as electrical, magnetic, mechanical, and physical. ● The importance of material testing as a verification process.	**Unit Objectives:** ***Students will be able to…...*** ● Create free body diagrams of objects, identifying all forces acting on the object. ● Mathematically locate the centroid of structural members. ● Calculate moment of inertia of structural members. ● Differentiate between scalar and vector quantities. ● Identify magnitude, direction, and sense of a vector. ● Calculate the X and Y components given a vector. ● Calculate moment forces given a specified axis. ● Use equations of equilibrium to calculate unknown forces.

	• Use the method of joints strategy to determine forces in the members of a statically determinate truss. • Investigate specific material properties related to a common household product. • Identify the recycling codes. • Promote recycle using current media trends. • Tensile test a material test sample. • Identify and calculate test sample material properties using a stress strain curve.

Lower Cape May Regional Principles of Engineering Curriculum
Unit 3 Overview

Content Area: Engineering

Unit Title: Control Systems

Target Course/Grade Level: Principles of Engineering / 10-12

Unit Summary:

- In this unit students will be able to create: detail flowcharts that utilize a computer software application, control system operating programs that utilize computer software, system control programs that utilize flowchart logic, and choose appropriate input and output devices based on the need of a technological system.

Interdisciplinary Connections: **Link to NJSLS**

- In addition to Technology standards, connections are linked to the New Jersey Student Learning Standards in Mathematics.
- **NJSLS Math G-SRT.C: Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems..** Students will build trusses and use the Pythagorean Theorem to calculate truss forces and angles.
- **NJSLS Math A-CED: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.** Students will rearrange the formula to solve pneumatic and hydraulic formulas and equations.

Resources: Effective Strategies for Interdisciplinary Teaching

Integration of 21st Century Skills

- **CRP1**-Students will act as responsible and contributing citizens*

- **CRP2-**Students will apply applicable academic skills*
- **CRP3-**Students will attend to personal health and financial well-being
- **CRP4-**Students will communicate effectively, clearly and with reason*
- **CRP5-**Students will consider the environmental, social, and economic impacts of decisions*
- **CRP6-**Students will demonstrate creativity and innovation*
- **CRP7-**Students will employ valid and reliable research strategies*
- **CRP8-**Students will utilize critical thinking to make sense of problems and persevere in solving* them
- **CRP9-**Students will model leadership, integrity, and effective management*
- **CRP10-**Students will plan education and career paths aligned to personal goals*
- **CRP11-**Students will utilize technology to enhance productivity*
- **CRP12-**Students will work productively in teams while using cultural, global competence*

For more information regarding 21st Century Skills and for classroom resources click here.

Integration of Technology Standards

- **Standard 8.1 Computer Science:** This outlines a comprehensive set of concepts and skills, such as data and analysis, algorithms and programming, and computing systems.
- **Standard 8.2 Design Thinking:** This outlines the technological design concepts and skills essential for technological and engineering literacy. The framework design includes Engineering Design, Ethics and Culture, and the Effects of Technology on the Natural world among the disciplinary concepts.

For more information regarding Technology Standards click here.

Integration of 21st Century Life and Career Standards

- **9.1 Personal Financial Literacy:** Students will understand the important fiscal knowledge, habits, and skills that must be mastered in order to make informed decisions about personal finance. Financial literacy is an integral component of a student's college and career readiness, enabling students to achieve fulfilling, financially-secure, and successful careers.

- **9.2 Career Awareness, Exploration, and Preparation:** Students will understand the importance of being knowledgeable about one's interests and talents, and being well informed about postsecondary and career options, career planning, and career requirements.*

- **9.3 Career and Technical Education:** Students will know and understand the expectations aligned with the completion of a CTE Program of Study.
  9.3.ST.2, 9.3.ST.6, 9.3.ST-ET.5,

For more information regarding 21st Century Life and Career Standards click here.

Learning Targets

Performance Expectation #	**Performance Expectation for Unit** **NJSLS Standards**
8.2.12.ED.2	Create scaled engineering drawings for a new product or system and make modifications 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).

Unit Enduring Questions:

- What are the advantages and disadvantages of using programmable logic to control machines versus monitoring and adjusting processes manually?
- What are some everyday seemingly simple devices that contain microprocessors, and what function do the devices serve?
- What questions must designers ask when solving problems in order to decide between digital or analog systems and between open or closed loop systems?
- Fluid power systems are categorized as either pneumatic, which utilizes gas, or hydraulic, which utilizes liquid.
- Fluid power is possible because in a system of confined fluid, pressure acts equally in all directions.
- The most basic components of all fluid power systems include a reservoir or receiver, a pump or compressor, a valve, and a cylinder.
- Fluid power systems are designed to transmit force over great distances, multiply an input force, and increase the distance that an output will move.

Unit Enduring Understandings:

- Flowcharts provide a step by step schematic representation of an algorithm or process.
- Control systems are designed to provide consistent process control and reliability.
- Control system protocols are an established set of commands or functions typically created in a computer programming language.
- Closed loop systems use digital and analog sensor feedback to make operational and process decisions.
- Open loop systems use programming constants such as time to make operational and process decisions.
- Fluid power systems are categorized as either pneumatic, which utilizes gas, or hydraulic, which utilizes liquid.
- Fluid power is possible because in a system of confined fluid, pressure acts equally in all directions.
- The most basic components of all fluid power systems include a reservoir or receiver, a pump or compressor, a valve, and a cylinder.
- Fluid power systems are designed to transmit force over great distances, multiply an input force, and increase the distance that an output will move.
- Laws about the behavior of fluid systems and standard conventions for calculating values within fluid systems aid in the design and understanding of such systems.

Unit Objectives:

Students will know….

- Students will explain the difference between digital and analog systems.
- Students will explain the difference between open and closed loop systems

Unit Objectives:

Students will be able to…..

- Create detailed flow charts that utilize a computer software application.
- Create control system operating programs that utilize computer software.

• Students will explain the difference between pneumatic and hydraulic systems. • Students will explain the basic components in a fluid power system.	• Create system control programs that utilize flowchart logic. • Choose appropriate input and output devices based on the need of a technological system. • Differentiate between the characteristics of digital and analog devices. • Judge between open and closed loop systems in order to choose the most appropriate system for a given technological problem. • Design and create a control system based on given needs and constraints. • Identify devices that utilize fluid power • Identify and explain basic components and functions of fluid power devices. • Differentiate between the characteristics of pneumatic and hydraulic systems. • Calculate values in a fluid power system utilizing Pascal's Law. • Distinguish between pressure and absolute pressure. • Distinguish between temperature and absolute temperature. • Calculate values in a pneumatic system utilizing the perfect gas laws. • Calculate flow rate, flow velocity, and mechanical advantage in a hydraulic system

Lower Cape May Regional Principles of Engineering Curriculum **Unit 4 Overview**
Content Area: Engineering
Unit Title: Statistics and Kinematics
Target Course/Grade Level: Principles of Engineering / 10-12
Unit Summary: In this unit students will learn the processes of gathering, organizing, interpreting, and formulating an understanding of data. Students will perform an activity that will help them to understand the kinematics concepts involved in projectile motion. Additionally, students will be able to calculate the theoretical probability that an event will occur.

Interdisciplinary Connections: **Link to NJSLS**

- In addition to Technology standards, connections are linked to the New Jersey Student Learning Standards in Mathematics and Science.

- **NJSLS Math S-CP.B: Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model. Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model. Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.** Students will create an activity involving dice and various objects to learn about probabilities of compound events.

  NJSLS Science PS2-1.A Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. Students will conduct problems on kinematics and motion, relating velocity, acceleration, mass, time, etc.

Resources: Effective Strategies for Interdisciplinary Teaching

Integration of 21st Century Skills

- **CRP1-**Students will act as responsible and contributing citizens*
- **CRP2-**Students will apply applicable academic skills*
- **CRP3-**Students will attend to personal health and financial well-being
- **CRP4-**Students will communicate effectively, clearly and with reason*
- **CRP5-**Students will consider the environmental, social, and economic impacts of decisions*
- **CRP6-**Students will demonstrate creativity and innovation*
- **CRP7-**Students will employ valid and reliable research strategies*
- **CRP8-**Students will utilize critical thinking to make sense of problems and persevere in solving them*
- **CRP9-**Students will model leadership, integrity, and effective management*
- **CRP10-**Students will plan education and career paths aligned to personal goals
- **CRP11-**Students will utilize technology to enhance productivity*
- **CRP12-**Students will work productively in teams while using cultural, global competence*

For more information regarding 21st Century Skills and for classroom resources click here.

Integration of Technology Standards

- **Standard 8.1 Computer Science:** This outlines a comprehensive set of concepts and skills, such as data and analysis, algorithms and programming, and computing systems.
- **Standard 8.2 Design Thinking:** This outlines the technological design concepts and skills essential for technological and engineering literacy. The framework design includes Engineering Design, Ethics and Culture, and the Effects of Technology on the Natural world among the disciplinary concepts.

For more information regarding Technology Standards click here.

Integration of 21st Century Life and Career Standards

- **9.1 Personal Financial Literacy:** Students will understand the important fiscal knowledge,

habits, and skills that must be mastered in order to make informed decisions about personal finance. Financial literacy is an integral component of a student's college and career readiness, enabling students to achieve fulfilling, financially-secure, and successful careers.

- **9.2 Career Awareness, Exploration, and Preparation:** Students will understand the importance of being knowledgeable about one's interests and talents, and being well informed about postsecondary and career options, career planning, and career requirements.

- **9.3 Career and Technical Education:** Students will know and understand the expectations aligned with the completion of a CTE Program of Study.
  9.3.ST.2, 9.3.ST.6

For more information regarding 21st Century Life and Career Standards click here.

Learning Targets

Performance Expectation #	**Performance Expectation for Unit NJSLS Standards**
8.2.12.ED.4	Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.
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.NT.2	Redesign an existing product to improve form or function.
8.1.12.DA.6	Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.

Unit Enduring Questions:

- Why is it crucial for designers and engineers to utilize statistics throughout the design process?
- Why is process control a necessary statistical process for ensuring product success?
- Why is theory-based data interpretation valuable in decision making?
- Why is experiment-based data interpretation valuable in decision

Unit Enduring Understandings:

- Engineers use statistics to make informed decisions based upon established principles.
- Visual representations of data analyses allow for easy distribution and understanding of data.
- Statistics is based upon both theoretical and experimental data analysis.
- When working with bodies in motion, engineers must be able to differentiate and calculate distance, displacement, speed, velocity, and acceleration.

making? ● What are the relationships between distance, displacement, speed, velocity, and acceleration? ● Why is it important to understand and be able to control the motion of a projectile?	● When air resistance is not taken into account, released objects will experience acceleration due to gravity, also known as freefall. ● Projectile motion can be predicted and controlled using kinematics equations. ● When a projectile is launched, velocity in the x direction remains constant; whereas, with time, the velocity in the Y direction in magnitude and direction changes due to gravity. ● When working with bodies in motion, engineers must be able to differentiate and calculate distance, displacement, speed, velocity, and acceleration. ● When air resistance is not taken into account, released objects will experience acceleration due to gravity, also known as freefall. ● Projectile motion can be predicted and controlled using kinematics equations. ● When a projectile is launched, velocity in the x direction remains constant; whereas, with time, the velocity in the Y direction in magnitude and direction changes due to gravity.
Unit Objectives: ***Students will know….*** ● How engineers use statistics. ● The importance of visual representation of data. ● The difference between theoretical and experimental data. ● How forces affect projectile motion. ● The process of determining range, max height, and velocity.	**Unit Objectives:** ***Students will be able to…...*** ● Calculate the theoretical probability that an event will occur. ● Calculate the experimental frequency distribution of an event occurring. ● Apply the Bernoulli process to events that only have two distinct possible outcomes. ● Apply AND, OR, and NOT logic to probability. ● Apply Bayes' theorem to calculate the probability of multiple events occurring. ● Create a histogram to illustrate frequency distribution. ● Calculate the central tendency of a data array, including mean, median, and mode. ● Calculate data variation, including range, standard deviation, and variance ● Calculate distance, displacement, speed, velocity, and acceleration from data. ● Calculate acceleration due to gravity given data from a free fall device.

	• Calculate the X and Y components of a projectile motion. • Determine the needed angle to launch a projectile a specific range given the projectile's initial velocity.

Lower Cape May Regional Principles of Engineering Curriculum **Evidence of Learning**
Specific Formative Assessments Utilized in Daily Lessons: • Academic Prompts • Informal Observation/ Discussions • Participation • Rubrics • Portfolios / Engineering Notebooks • Demonstrations/Presentations • Checklists • Text-based Analysis questions • Discussion questions • Daily classwork worksheets • Homework • Short writing prompts
Summative Assessment Utilized throughout Units: • Formal Essays • Unit Tests • Creative Projects
Modifications for Special Education • Teacher tutoring • Peer tutoring • Cooperative Learning Groups • Modified Assignments • Differentiated Instruction • Response to Intervention (www.help4teachers.com) • Follow all IEP modifications
Accommodations for 504 & GATE • Tiered instruction • Visual aids as necessary • Guided Notes • Closed-captioning (ELL students) • Written/displayed as well as verbal instruction

- Modified tests and quizzes
- Extended due-dates for assignments
- Extra copies of textbooks and other resources
- Work linked to teacher websites
- Preferential seating
- Books on tape and audiobooks
- Student choice in selected assessments
- Tiered/scaffolded grouping for assignments and classwork
- Writing conferences with teacher
- Engage in higher level questioning
- Brainstorm learning projects together
- Use thematic instruction to connect learning across the curriculum.
- Encourage creative expression and thinking by allowing students to choose how to approach a problem or assignment.
- RTI: Judy Elliot Video Resource

Accommodations for ELL Students

- Increased wait time
- Cooperative learning groups
- Utilization of visuals (graphic organizers, labeling)
- Modeling, role play, act-it out
- Simplify complex questions
- Emphasize 5-8 key vocabulary words per lesson.
- Print, and avoid cursive/manuscript when applicable
- Check often for comprehension.
- Modify assignments as needed
- Provide a variety of texts of multiple levels.

Accommodations for At-Risk Students

- Visual Reminders
- Demonstration and Modeling
- Include hands-on experiences and manipulatives when possible.
- Continue to repeat and rephrase the major point(s) of the unit or lesson.
- Insert meanings of vocabulary continuously throughout the lesson.
- Demonstrate how to use graphic organizers and then provide them so students learn how to categorize and organize information.
- Provide study guides for tests well in advance of the test.
- Offer copies of lecture notes to students who cannot copy accurately or quickly, have poor penmanship, or note-taking skills. Throughout the year help students fix their own notes using yours as a guide.
- Reduce the variety of tasks
- Teach writing each day; don't just assign it
- Utilize a graphic organizer for organization
- More ideas here

Teacher Notes:

- As required by the NJ Department of Education, teachers in all content areas will integrate the 21st Century Life and Careers Standards. As the NJDOE indicates, "Providing New Jersey students with the life and career skills needed to function optimally within this dynamic context is a critical focus and organizing principle of K-12 public education. New Jersey has both an obligation to prepare its young people to thrive in this environment, and a vested economic interest in grooming an engaged citizenry made up of productive members of a global workforce that rewards innovation, creativity, and adaptation to change." The links below indicate the CPIs for grade ranges and need to be addressed throughout the units of study:
  Life and Career Standards

Project-based Learning Tasks:

- Creation of a simple machine using VEX equipment
- Construction of both a simple and complex gear train using Vex equipment
- Creation of a Hydrogen Fuel Cell & Solar Powered Vehicle
- Design a renewable composite insulation material.
- Truss Design
- Machine Control Design (Various Designs)

Vocabulary:

- In-text vocabulary should be incorporated into every unit. Word journals, vocabulary walls, and/or various other activities should be utilized by the instructor to teach vocabulary.

The Research Process:

The research process must be integrated within each course curriculum. Student will be provided with opportunities to investigate issues from thematic units of study. As the NJSLS indicate, students will develop proficiency with MLA or APA format as applicable.

- As necessary, students have access to The Follett Destiny library catalog through the school library.
- Additional research pages can be accessed through the high school website by clicking under the students tab. (https://oceancityschools.org/highschool/research)

Technology:

Students must engage in technology applications integrated throughout the curriculum. Applicable technology utilized in this curriculum are included below

- Autodesk Revit
- Google Classroom
- MD Solids
- Bridge Designer
- ROBOTC Software
- VEX Robotics Platform
- Circuit Simulator
- Logger Pro
- Vernier Temperature Probe
- Vernier Force Sensors

Resources:
Ancillary resources and materials used to deliver instruction are included below:

- PowerPoints
- Google Classroom
- Document Camera
- MD Solids
- ROBOTC Software
- VEX Robotics Platform
- Circuit Simulator
- Logger Pro
- Vernier Temperature Probe
- Vernier Force Sensor

Differentiation Strategies

Differentiation strategies can require varied amounts of preparation time. High-prep strategies often require a teacher to both create multiple pathways to process information/demonstrate learning and to assign students to those pathways. Hence, more ongoing monitoring and assessment is often required. In contrast, low-prep strategies might require a teacher to strategically create process and product choices for students, but students are allowed to choose which option to pursue given their learning profile or readiness level. Also, a low-prep strategy might be focused on a discrete skill (such as vocabulary words), so there are fewer details to consider. Most teachers find that integration of one to two new low-prep strategies and one high-prep strategy each quarter is a reasonable goal.

Low Prep Strategies (add to list as needed)	
Varied journal prompts, spelling or vocabulary lists	Students are given a choice of different journal prompts, spelling lists or vocabulary lists depending on level of proficiency/assessment results.
Anchor activities	Anchor activities provide meaningful options for students when they are not actively engaged in classroom activities (e.g., when they finish early, are waiting for further directions, are stumped, first enter class, or when the teacher is working with other students). Anchors should be directly related to the current learning goals.
Choices of books	Different textbooks or novels (often at different levels) that students are allowed to choose from for content study or for literature circles.
Choices of review activities	Different review or extension activities are made available to students during a specific section of the class (such as at the beginning or end of the period).
Homework options	Students are provided with choices about the assignments they

	complete as homework. Or, students are directed to specific homework based on student needs.
Student-teacher goal setting	The teacher and student work together to develop individual learning goals for the student.
Flexible grouping	Students might be instructed as a whole group, in small groups of various permutations (homogeneous or heterogeneous by skill or interest), in pairs or individual. Any small groups or pairs change over time based on assessment data.
Varied computer programs	The computer is used as an additional center in the classroom, and students are directed to specific websites or software that allows them to work on skills at their level.
Multiple Intelligence or Learning Style options	Students select activities or are assigned an activity that is designed for learning a specific area of content through their strong intelligence (verbal-linguistic, interpersonal, musical, etc.)
Varying scaffolding of same organizer	Provide graphic organizers that require students to complete various amounts of information. Some will be more filled out (by the teacher) than others.
Think-Pair-Share by readiness, interest, and/or learning profile	Students are placed in predetermined pairs, asked to think about a question for a specific amount of time, then are asked to share their answers first with their partner and then with the whole group.
Mini workshops to re-teach or extend skills	A short, specific lesson with a student or group of students that focuses on one area of interest or reinforcement of a specific skill.
Orbitals	Students conduct independent investigations generally lasting 3-6 weeks. The investigations "orbit" or revolve around some facet of the curriculum.
Games to practice mastery of information and skill	Use games as a way to review and reinforce concepts. Include questions and tasks that are on a variety of cognitive levels.
Multiple levels of questions	Teachers vary the sorts of questions posed to different students based on their ability to handle them. Varying questions is an excellent way to build the confidence (and motivation) of students who are reluctant to contribute to class discourse. Note: Most teachers would probably admit that without even thinking about it they tend to address particular types of questions to particular students. In some cases, such tendencies may need to be corrected. (For example, a teacher may be unknowingly addressing all of the more challenging questions to one student, thereby inhibiting other students' learning and fostering class resentment of that student.)

High Prep Strategies (add to list as needed)	
Cubing	Designed to help students think about a topic or idea from many different angles or perspectives. The tasks are placed on the six sides of a cube and use commands that help support thinking (justify, describe, evaluate, connect, etc.). The students complete the task on the side that ends face up, either independently or in homogenous groups.
Tiered assignment/ product	The content and objective are the same, but the process and/or the products that students must create to demonstrate mastery are varied according to the students' readiness level.
Independent studies	Students choose a topic of interest that they are curious about and wants to discover new information on. Research is done from questions developed by the student and/or teacher. The researcher produces a product to share learning with classmates.
4MAT	Teachers plan instruction for each of four learning preferences over the course of several days on a given topic. Some lessons focus on mastery, some on understanding, some on personal involvement, and some on synthesis. Each learner has a chance to approach the topic through preferred modes and to strengthen weaker areas
Jigsaw	Students are grouped based on their reading proficiency and each group is given an appropriate text on a specific aspect of a topic (the economic, political and social impact of the Civil War, for example). Students later get into heterogeneous groups to share their findings with their peers, who have read about different areas of study from source texts on their own reading levels. The jigsaw technique allows you to tackle the same subject with all of your students while discreetly providing them the different tools they need to get there.
Multiple texts	The teacher obtains or creates a variety of texts at different reading levels to assign strategically to students.
Alternative assessments	After completing a learning experience via the same content or process, the student may have a choice of products to show what has been learned. This differentiation creates possibilities for students who excel in different modalities over others (verbal versus visual).
Modified Assessments	Assessments can be modified in a variety of ways – for example by formatting the document differently (e.g. more space between questions) or by using different types of questions (matching vs. open ended) or by asking only the truly essential questions.

Learning contracts or Personal Agendas	A contract is a negotiated agreement between teacher and student that may have a mix of requirements and choice based on skills and understandings considered important by the teacher. A personal agenda could be quite similar, as it would list the tasks the teacher wants each student to accomplish in a given day/lesson/unit. Both Learning contracts and personal agendas will likely vary between students within a classroom.
Compacting	This strategy begins with a student assessment to determine level of knowledge or skill already attained (i.e. pretest). Students who demonstrate proficiency before the unit even begins are given the opportunity to work at a higher level (either independently or in a group).
Literature circles	Flexible grouping of students who engage in different studies of a piece of literature. Groups can be heterogeneous and homogeneous.
Learning Centers	A station (or simply a collection of materials) that students might use independently to explore topics or practice skills. Centers allow individual or groups of students to work at their own pace. Students are constantly reassessed to determine which centers are appropriate for students at a particular time, and to plan activities at those centers to build the most pressing skills.
Tic-Tac-Toe Choice Board (sometimes called "Think-Tac-Toe"	The tic-tac-toe choice board is a strategy that enables students to choose multiple tasks to practice a skill, or demonstrate and extend understanding of a process or concept. From the board, students choose (or teacher assigns) three adjacent or diagonal. To design a tic-tac-toe board: - Identify the outcomes and instructional focus - Design 9 different tasks - Use assessment data to determine student levels - Arrange the tasks on a tic-tac-toe board either randomly, in rows according to level of difficulty, or you may want to select one critical task to place in the center of the board for all students to complete.

Curriculum development Resources/Instructional Materials:

List or Link Ancillary Resources and Curriculum Materials Here:

- Project Lead the Way Online Curriculum

BOE Approved Text

- N/A

-