DELAWARE VALLEY SCHOOL DISTRICT

PLANNED INSTRUCTION

A PLANNED COURSE FOR:

Engineering 2 (Principles of Engineering)

Grade Level: 10-12

Date of Board Approval: _____2014_____

DELAWARE VALLEY SCHOOL DISTRICT

Planned Instruction

Title of Planned Instruction: Engineering 2 (Principles of Engineering)

Subject Area: Engineering Grade(s): 10-12

Course Description:
This course, also known as Principles of Engineering Design (POE), is the second course in the PLTW Pathway to Engineering program and is a high school-level survey course of engineering. The course exposes students to some of the major concepts that they will encounter in a postsecondary engineering course of study. Students have an opportunity to investigate engineering and high tech careers. POE gives students the opportunity to develop skills and understanding of course concepts through activity, project, and problem-based learning. To be successful in POE, students should be concurrently enrolled in college preparatory mathematics and science. Students will employ engineering and scientific concepts in the solution of engineering design problems. Students will develop problem-solving skills and apply their knowledge of research and design to create solutions to various challenges. Students will also learn how to document their work and communicate their solutions to their peers and members of the professional community.

Time/Credit for the Course: Full Year, 1 credit

Curriculum Writing Committee: Robert Curtis

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Curriculum Map

1. **Marking Period One -Overview with time range in days:**
   Unit 1.1: Mechanisms are the basic components of most machines and consist of gears, sprockets, pulley systems, and simple machines. 25-27 days
   Unit 1.2: Energy used to power mechanisms comes from many different sources and energy losses in mechanisms are inevitable. 10-11 days
   Unit 1.3: Thermodynamic concepts allow engineers to explain and quantify how energy is transferred and how it moves through physical systems. 5-7 days

   Marking Period One -Goals:
   Understanding of how to:
   - Differentiate between engineering and engineering technology.
   - Conduct a professional interview and reflect on it in writing.
   - 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.
   - Design, create, test, and evaluate a compound machine design. Identify and categorize energy sources as nonrenewable, renewable, or inexhaustible.
   - Create and deliver a presentation to explain a specific energy source.
   - Summarize and reflect upon information collected during a visit to a local utility company.
   - Define the possible types of power conversion.
   - Calculate work and power.
   - Demonstrate the correct use of a digital multimeter.
   - Calculate power in a system that converts energy from electrical to mechanical.
   - Determine efficiency of a system that converts an electrical input to a mechanical output.
   - 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.

2. **Marking Period Two -Overview with time range in days:**
   Unit 1.3: Thermodynamic concepts allow engineers to explain and quantify how energy is transferred and how it moves through physical systems. (continued) 5-6 days
   Unit 1.4: Engineers use knowledge of energy generation and energy transport to solve problems. 10-11 days
   Unit 2.1: Statics concepts allow engineers to design structures that are in static (not moving) equilibrium. 18-19 days
   Unit 2.2: Engineers use material properties in order to select the best material for a specific application. 7-9 days

   Marking Period Two -Goals:
   Understanding of how to:
   - 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. Brainstorm and sketch possible solutions to an existing design problem.
   - Create a decision making matrix for their design problem.
   - Select an approach that meets or satisfies the constraints provided in a design brief.
   - Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon the design team's decision matrix.
   - Present a workable solution to the design problem.
   - Complete calculations for conduction, R-values, and radiation. 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.

- Conduct investigative non-destructive material property tests on selected common household product including testing for continuity, ferrous metal, hardness, and flexure.
- Calculate weight, volume, mass, density, and surface area of selected common household product
- Identify the manufacturing processes used to create the selected common household product.
- Identify the recycling codes.
- Promote recycle using current media trends.

3. **Marking Period Three -Overview with time range in days:**

Unit 2.2: Engineers use material properties in order to select the best material for a specific application. (continued) 8-9 days
Unit 2.3: Material testing determines the reliability, safety, and functional predictability of a material. 10-11 days
Unit 2.4: Engineers use information on material properties and material testing to solve practical problems. 5-6 days
Unit 3.1: Mechanical processes are many times controlled by computer software and hardware. 17-19 days

Marking Period Three -Goals
Understanding of how to:

- Investigate specific material properties related to a common household product.
- Conduct investigative non-destructive material property tests on selected common household product including testing for continuity, ferrous metal, hardness, and flexure.
- Calculate weight, volume, mass, density, and surface area of selected common household product
- Identify the manufacturing processes used to create the selected common household product.
- Identify the recycling codes.
- Promote recycle using current media trends.
- Utilize a five-step technique to solve word problems.
- Obtain measurements of material samples.
- Tensile test a material test sample.
- Identify and calculate test sample material properties using a stress strain curve.
- Brainstorm and sketch possible solutions to an existing design problem.
- Create a decision making matrix for the design problem.
- Select an approach that meets or satisfies the constraints given in a design brief.
- Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon your team's decision matrix.

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

4. **Marking Period Four –Overview with time range in days:**
   Unit 3.2: Pneumatic and hydraulic fluid power systems are used to power and control many types of mechanisms. 13-14 days
   Unit 3.3: Engineers build mechanical devices and electronic control systems to solve practical problems. 15-16 days
   Unit 4.1: Engineers use statistical analysis to make decisions about engineering processes and designs. 6-8 days
   Unit 4.2: Engineers use kinematics to accurately describe motion of objects. 6-7 days

   Marking Period Four -Goals:
   Understanding of how to:
   - 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.
   - Distinguish between hydrodynamic and hydrostatic systems.
   - Design, create, and test a hydraulic device.
   - Design, create, and test a pneumatic device.
   - 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.
   - Brainstorm and sketch possible solutions to an existing design problem.
   - Create a decision-making matrix for their design problem.
   - Select an approach that meets or satisfies the constraints provided in a design brief.
   - Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon the design team's decision matrix.
   - Present a workable solution to the design problem.
   - 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.
- Design, build, and test a vehicle that stores and releases potential energy for propulsion.
- 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.

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UNIT: 1.1 Mechanisms

Big Idea # 1:

- A technological world requires that humans develop capabilities to solve technological challenges and improve products for the way we live.

Essential Questions:

- How have technological developments impacted devices, processes, and systems for the way we live?

Concepts:

- The abilities required in a technological world include diagnosing, troubleshooting, analyzing and maintaining systems.
- Innovation is the process of modifying an existing product, process, or system to improve it.
- Invention is a process of turning ideas and imagination into new products, processes, or systems.
- Safety is a preeminent concern for all technological development and use.

Competencies:

- Develop the abilities to use and maintain technological products and systems.
- Improve an existing product, process, or system.
- Create a new product, process, or system.
- Safely use tools, machines, and electronic devices.
- Explain the importance of carefully assessing technological inventions and innovations.

Big Idea #2:

- Each area of technology has a set of characteristics that separates it from others; however, many areas overlap in order to meet human needs and wants.

Essential Questions:

- How do various areas of technology influence the economy, the environment, and society?

Concepts:

- Energy and power technologies are the processes of converting energy sources into useful power.

Competencies:

- Design and develop the ability to safely and effectively use tools and materials to manufacture products.
- Design and develop the ability to safely and effectively use tools and materials to build structures.
- Design and develop the ability to safely and effectively use tools and materials to convert energy into useful power.

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Big Idea # 3:

- Technology is created, used and modified by humans.

Essential Questions:

- What knowledge and skills are essential for humans to make sound decisions about creating, using, and modifying technologies?

Concepts:

- Decisions about the use of products and systems can result in known and unexpected consequences.
- The study of the impacts of technological systems enables us to plan and direct technological developments.
- The use of technology involves weighing the trade-offs of the positive and negative effects.
- Science is the study of the natural world and technology is the study of the human designed world but both are inextricably connected.
- Human decision making (e.g. Human needs and wants plus cultural considerations) drives the selection and/or use of technologies.
- Creating optimal solutions under constraints are a primary component of technological problem solving (e.g., tools/machines, materials, information, people, capital, energy, and time).

Competencies:

- Explain how making informed decisions about the development and use of technology may have known and unexpected consequences.
- Describe the nature of technology and the consequences of technological activity which impact society and the world.
- Explain how technology has and can change the human condition throughout time.
- Differentiate between the study of science and technology.
- Describe the complementary roles of scientific knowledge and technological application.
- Demonstrate how technological progress promotes the advancement of science, technology, engineering and mathematics (STEM).
- Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness and the ability to visualize and think abstractly.

Big Idea # 4:

- Technological literacy is the ability to use, assess and manage technology around us.

Essential Questions:

- What is technological literacy?

Concepts:

- Technology and society mutually impact each other.
- Technological literacy is the ability to understand, use, assess, design, and produce technology (i.e. Invention & Innovation).
- Technological literacy is necessary for a productive 21st century skilled workforce.

- People select, create, and use science and technology and are limited by constraints (e.g. social and physical).

Competencies:

- Design and produce solutions to technological problems.
- Develop skills for a 21st century workforce.
- Compare and contrast the natural constraints imposed on scientific and technological change.

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Curriculum Plan

Unit 1.1 Mechanisms **Time Range in Days: 25-27**

Standard(s): PA Academic Standards, PACCS Reading and Writing for Science and Technology

Standards Addressed: (Number Only- See Appendix for Description)
PA Academic Standards: 3.4.10.A2, 3.4.12.A.1, 3.4.10.B1, 3.4.10.B2, 3.4.10.B4, 3.4.10.C1, 3.4.10.C2, 3.4.12.C2, 3.4.12.C3, 3.4.10.D1, 3.4.10.D2, 3.4.10.D3, 3.4.12.D2, 3.4.12.E6

PACCS: CC.3.5.9-10.A, CC.3.5.9-10.B, CC.3.5.9-10.C, CC.3.5.9-10.D, CC.3.5.9-10.J, CC.3.5.9-10.E CC.3.6.9-10.A., CC.3.6.9-10.B., CC.3.6.9-10.C., CC.3.6.9-10.E, CC.3.6.9-10.F, CC.3.6.9-10.G, CC.3.6.9-10.H, CC.3.6.9-10.I.

Anchor(s): S8.A.1.1, S8.A.1.2, S8.A.1.3, S8.A.2.1, S8.C.2.1, S11.A.1.2, S11.A.1.3, S11.A.2.1, S11.A.2.2, S11.A.3.1, S11.A.3.2, S11.A.3.3, S11.B.1.1, S11.B.3.2, S11.C.2.1, S11.C.2.2, S11.C.3.1

Overview: Mechanisms are the basic components of most machines and consist of gears, sprockets, pulley systems, and simple machines.

Focus Question(s): 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?

Goals: It is expected that students will:

- Differentiate between engineering and engineering technology.
- Conduct a professional interview and reflect on it in writing.
- 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.

- Design, create, test, and evaluate a compound machine design.

Objectives:

(Include DOK Levels)

1. Students shall understand what engineers and engineering technologists do. (DOK Level 1)
2. Students shall understand what different types of job functions engineers and engineering technologists perform. (DOK Level 2)
3. Students shall identify the six simple machines and how to calculate their mechanical advantages. (DOK Level 1)
4. Students shall be able to conduct a professional interview and reflect upon it in writing. (DOK Level 3)
5. Students shall design, create, and test gear, pulley, and sprocket compound machine systems to solve real world problems. (DOK Level 4)

Core Activities and Corresponding Instructional Methods:

Part 1:

- **Direct and Independent Instruction**
- The teacher will distribute course and school specific materials relating to Principles of Engineering course expectations and procedures.
- The teacher will distribute an engineering notebook to each student or have students create their own.
- The teacher will distribute Sample Engineering Notebook Entries to each student and discuss what constitutes acceptable and unacceptable entries.
- The teacher will present Engineering Notebook.ppt. Note: The teacher may want to present the extended version of this presentation. The extended version is located in the Instructional Resources at the top of this lesson document.

Part 2:

- **Direct and Independent Instruction**
- The teacher will present Careers in Engineering and Engineering Technology.ppt.
- Students will take notes during the presentation in their journals.
- The teacher will distribute and explain Professional Interview and Professional Interview Rubric.
- The teacher will lead a discussion about how to contact professionals and request an interview and how to best conduct those interviews. Students will be given a due date for contacting the interviewee and for the Professional Interview activity to be completed and submitted.

Part 3:

- **Direct Instruction**
- The teacher will present Concepts, Key Terms, and Essential Questions to provide a lesson overview.
- The teacher will present Simple Machine – Lever, Wheel and Axle, and Pulley.ppt.
- Students will take notes during the presentation in their journals.

Parts 4-8:

- **Direct and Independent Instruction and Cooperative Learning**
- The teacher will distribute, explain, and assign Activity 1.1.1 Simple Machine Investigation (FT).
- Students will complete part one of Activity 1.1.1 Simple Machine Investigation.
- The teacher will circulate around the lab to be sure that the students are gathering accurate data.
- The teacher will present Simple Machines – Inclined Plane, Wedge, and Screw.ppt.
- Students will take notes during the presentation in their journals.
- Students will complete Part two of Activity 1.1.1 Simple Machine Investigation
- The teacher will collect Activity 1.1.1 Simple Machine Investigation for assessment, check conclusion questions for completion, and lead a class discussion using those questions to assess students.
- The teacher will distribute, explain, and assign Activity 1.1.2 Simple Machines Practice Problems for homework.
- Students will be given a copy of Understanding Thread Notes in order to complete Simple Machines Practice Problems.
- Students will individually complete Activity 1.1.2 Simple Machines Practice Problems and the conclusion questions.

Part 9:

- **Direct Instruction**
- The teacher will collect Activity 1.1.2 Simple Machines Practice Problems for assessment, check conclusion questions for completion, and lead a class discussion using those questions to assess students.
- The teacher will present Gears, Pulley Drives, and Sprockets.ppt.
- Students will take notes during the presentation in their journals.

Part 10:

- **Independent Practice**
- The teacher will distribute, explain, and assign Activity 1.1.3 Gears (FT).
- Students will individually complete Activity 1.1.3 Gears and the conclusion questions.
- Students will document their design ideas generated for Activity 1.1.3 Gears in their journals.

Part 11:

- **Independent Practice**
- The teacher will review and collect Activity 1.1.3 Gears for assessment, check conclusion questions for completion, and lead a class discussion using those questions to assess students.
- The teacher will distribute, explain, and assign Activity 1.1.4 Pulley Drives and Sprockets.
- Students will individually complete Activity 1.1.4 Pulley Drives and Sprockets and the conclusion questions.
- The teacher will distribute, explain, and assign Activity 1.1.5 Gear, Pulley Drives, and Sprocket Practice Problems.

Part 12:

- **Independent Instruction**
- The teacher will review and collect Activity 1.1.5 Simple Machines Practice Problems and Gears, Pulley Drives, and Sprockets Practice Problems for assessment, check conclusion questions for completion, and lead a class discussion using those questions to assess students.
- Students will be introduced to Project 1.1.6 Compound Machine Design (FT).
- Students will be given a copy of Project 1.1.6 Compound Machine Design Rubric to review and return for evaluation with their final documentation and design.

Parts 13-17:

- **Cooperative Learning**
- In teams of four, students will design, build, and test their solutions to Problem 1.1.6 Compound Machine Design.
- The teacher may present Mechanism Examples.ppt (FT) to help students with brainstorming solutions.
- The teacher will evaluate Problem 1.1.6 Compound Machine Design.

Also, assign readings from textbook on material as appropriate.

Assessments:

Diagnostic: Warmup Question Responses, performance and responses on Activity 1.1.1 Simple Machine Investigation

Formative: Performance and responses on Activities 1.1.2 through 1.1.5, Quizzes on Textbook reading assignments

Summative: Project 1.1.6, Unit Test

Extensions:

1. Textbook "Extra Mile" Challenges.
2. Additional readings and quizzes from textbook.

Correctives:

1. Additional independent design challenges.
2. More extensive direct instruction and modeling of the design process and proper documentation.
3. More extensive direct instruction on simple machine, gears, and sprocket calculations with additional practice problems.
4. Additional practice worksheets from textbook's workbook.
5. Additional readings and quizzes on mechanisms in textbook .

Materials and Resources:

Print Texts: *Principles of Engineering*

Web sites: my.pltw.org for Powerpoints, Activities, and Projects

Other Resources: fischertechnik kits

DELAWARE VALLEY SCHOOL DISTRICT

UNIT: 1.2 Energy Sources

Big Idea # 1:

- A technological world requires that humans develop capabilities to solve technological challenges and improve products for the way we live.

  Essential Questions:
  - How have technological developments impacted devices, processes, and systems for the way we live?

  Concepts:
  - The abilities required in a technological world include diagnosing, troubleshooting, analyzing and maintaining systems.
  - Innovation is the process of modifying an existing product, process, or system to improve it.
  - Invention is a process of turning ideas and imagination into new products, processes, or systems.
  - Safety is a preeminent concern for all technological development and use.

  Competencies:
  - Develop the abilities to use and maintain technological products and systems.
  - Improve an existing product, process, or system.
  - Create a new product, process, or system.
  - Safely use tools, machines, and electronic devices.
  - Explain the importance of carefully assessing technological inventions and innovations.

Big Idea #2:

- Each area of technology has a set of characteristics that separates it from others; however, many areas overlap in order to meet human needs and wants.

  Essential Questions:
  - How do various areas of technology influence the economy, the environment, and society?

  Concepts:
  - Energy and power technologies are the processes of converting energy sources into useful power.

  Competencies:
  - Design and develop the ability to safely and effectively use tools and materials to manufacture products.
  - Design and develop the ability to safely and effectively use tools and materials to convert energy into useful power.

Big Idea # 3:

- Technological design is a creative process that anyone can do which may result in new inventions and innovations.

Essential Questions:

- How would you apply technological design and problem solving methods in the development of inventions and innovations?

Concepts:

- Technological design & problem solving utilizes a series of steps that take place in a well-defined sequence.
- Technological design & problem solving transforms an idea into a final product or system.
- Technological design & problem solving requires the application of hands-on abilities such as sketching, prototyping, and fabricating.
- Technological design & problem solving includes both formative and summative analysis.
- Technological design & problem solving requires the ability to clearly communicate engineered solutions.

Competencies:

- Use design and problem solving skills to solve technological challenges.
- Transform ideas into technological products and/or systems.
- Use hands-on skills to create useful products and solve technological challenges.
- Describe and demonstrate how to use the technological method to analyze technological processes and solutions.
- Clearly communicate engineered solutions in written, spoken, and graphical means.

Big Idea # 4:

- Technology is created, used and modified by humans.

Essential Questions:

- What knowledge and skills are essential for humans to make sound decisions about creating, using, and modifying technologies?

Concepts:

- Decisions about the use of products and systems can result in known and unexpected consequences.
- The study of the impacts of technological systems enables us to plan and direct technological developments.
- The use of technology involves weighing the trade-offs of the positive and negative effects.
- Science is the study of the natural world and technology is the study of the human designed world but both are inextricably connected.
- Human decision making (e.g. Human needs and wants plus cultural considerations) drives the selection and/or use of technologies.
- Creating optimal solutions under constraints are a primary component of technological problem solving (e.g., tools/machines, materials, information, people, capital, energy, and time).

Competencies:

- Explain how making informed decisions about the development and use of technology may have known and unexpected consequences.
- Describe the nature of technology and the consequences of technological activity which impact society and the world.
- Explain how technology has and can change the human condition throughout time.
- Differentiate between the study of science and technology.
- Describe the complementary roles of scientific knowledge and technological application.
- Demonstrate how technological progress promotes the advancement of science, technology, engineering and mathematics (STEM).
- Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness and the ability to visualize and think abstractly.

Big Idea # 5:

- Technological literacy is the ability to use, assess and manage technology around us.

Essential Questions:

- What is technological literacy?

Concepts:

- Technology and society mutually impact each other.
- Technological literacy is the ability to understand, use, assess, design, and produce technology (i.e. Invention & Innovation).
- Technological literacy is required for all citizens in a democratic society for shared decision-making.
- Technological literacy is necessary for a productive 21st century skilled workforce.
- People select, create, and use science and technology and are limited by constraints (e.g. social and physical).

Competencies:

- Describe how technological development impacts economics, culture, and policies.
- Design and produce solutions to technological problems.
- Recognize the importance of using technological knowledge to participate competently in a democratically society.
- Develop skills for a 21st century workforce.
- Recognize technological literacy as a necessary lifetime endeavor which requires additional knowledge and information.
- Compare and contrast the natural constraints imposed on scientific and technological change.

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Curriculum Plan

Unit 1.2 Energy Sources **Time Range in Days: 10-11**

Standard(s): PA Academic Standards, PACCS Reading and Writing for Science and Technology

Standards Addressed: (Number Only- See Appendix for Description)
PA Academic Standards: 3.4.10.A1, 3.4.10.A2, 3.4.12.A.1, 3.4.10.B1, 3.4.10.B2, 3.4.10.B3, 3.4.10.B4, 3.4.12.B1, 3.4.12.B2, 3.4.10.C1, 3.4.10.C2, 3.4.12.C2, 3.4.12.C3, 3.4.10.D1, 3.4.10.D2, 3.4.10.D3, 3.4.12.D2, 3.4.10.E3, 3.4.12.E2, 3.4.12.E3

PACCS: CC.3.5.9-10.A, CC.3.5.9-10.B, CC.3.5.9-10.C, CC.3.5.9-10.D, CC.3.5.9-10.J, CC.3.5.9-10.E CC.3.6.9-10.A., CC.3.6.9-10.B., CC.3.6.9-10.C., CC.3.6.9-10.E, CC.3.6.9-10.F, CC.3.6.9-10.G, CC.3.6.9-10.H, CC.3.6.9-10.I.

Anchor(s): S8.A.1.1, S8.A.1.2, S8.A.1.3, S8.A.2.1, S8.C.2.1, S8.C.2.2, S11.A.1.2, S11.A.1.3, S11.A.2.1, S11.A.2.2, S11.A.3.1, S11.A.3.2, S11.A.3.3, S11.B.1.1, S11.B.3.2, S11.B.3.3, S11.C.1.1, S11.C.2.1, S11.C.2.2, S11.C.3.1, S11.D.1.2

Overview: Energy used to power mechanisms comes from many different sources and energy losses in mechanisms are inevitable.

Focus Question(s): What sources of energy are available for use? What are the benefits and drawbacks regarding efficiency, usefulness, and the environment? What emerging technologies are or may be on the horizon that will provide energy more efficiently? What are the different energy sources that are used to deliver energy to your community? What are some examples in your community of individuals or businesses harnessing their own energy? Where and how is electricity that reaches your home produced? What are some examples of inefficient use of energy and power at home, school, or work? What is the relationship between resistance, current, and voltage within an electrical system? What are the distinguishing characteristics between series and parallel circuits? How do you calculate the efficiency of an electrical mechanical system?

Goals: It is expected that students will:

- Identify and categorize energy sources as nonrenewable, renewable, or inexhaustible.
- Create and deliver a presentation to explain a specific energy source.

- Summarize and reflect upon information collected during a visit to a local utility company.
- Define the possible types of power conversion.
- Calculate work and power.
- Demonstrate the correct use of a digital multimeter.
- Calculate power in a system that converts energy from electrical to mechanical.
- Determine efficiency of a system that converts an electrical input to a mechanical output.
- 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.

Objectives:

(Include DOK Levels)

1. Students shall be able to categorize energy sources as nonrenewable, renewable, or inexhaustible. (DOK Level 2)
2. Students shall have a basic understanding of how electrical power is produced and distributed in their geographical area. (DOK Level 1)
3. Students shall be able to construct and mathematically analyze basic electrical circuits. (DOK Level 4)
4. Students shall understand the engineering terms "work", "energy" and "power" and calculate these properties for real world situations. (DOK Level 4)
5. Students shall construct an electro-mechanical device and mathematically analyze its capabilities and performance. (DOK Level 4)

Core Activities and Corresponding Instructional Methods:

Part 1:

- **Direct Instruction and Cooperative Learning**
- The teacher will present Concepts**,** Key Terms, and Essential Questions to provide a lesson overview.
- The teacher will present Energy Sources.ppt.
- Students will take notes during the presentation in their journals.
- The teacher will distribute and explain Activity 1.2.1 Energy Sources and Activity 1.2.1 Energy Sources Rubric**.**
- The teacher will assign teams and facilitate topic selection so that students may begin work on Activity 1.2.1 Energy Sources.
- The teacher will announce what day the presentations will be given.

- The teacher will distribute and explain Activity 1.2.2 Energy Distribution in order to prepare students for a field trip to a local utility company.

Part 2:

- **Direct Instruction**
- The teacher will present Introduction to Electricity.ppt.
- Students will take notes during the presentation in their journals.

Parts 3 - 4:

- **Direct Instruction and Cooperative Learning**
- The teacher will finish presenting Introduction to Electricity.ppt.
- Students will take notes during the presentation in their journals.
- The teacher will present Breadboarding and Electronics.ppt.
- Students will take notes during the presentation in their journals.
- The teacher will distribute and explain Activity 1.2.3 Electrical Circuits (physical).
- Students will complete Activity 1.2.3 Electrical Circuits (physical).
- Teacher will collect Activity 1.2.3 Electrical Circuits (physical) and evaluate it using Activity 1.2.3 Electrical Circuits (physical) Answer Key.

Part 5:

- **Independent Practice**
- The teacher will distribute and explain Activity 1.2.4 Circuit Calculations.
- Students will work on Activity 1.2.4 Electrical Circuits and complete for homework.

Part 6:

- **Cooperative Learning**
- The teacher will collect and evaluate Activity 1.2.4 Electrical Calculations Circuits using Activity 1.2.4 Electrical Circuits Calculations Answer Key.
- The teacher and students will visit a local utility company in order to complete Activity 1.2.2 Energy Distribution.

Part 7:

- **Cooperative Learning**
- The class will deliver presentations for Activity 1.2.1 Energy Sources.

Part 8:

- **Direct Instruction**
- The teacher will present Work, Energy, and Power.ppt.
- Students will take notes during the presentation in their journals.

Part 9:

- **Cooperative Learning**
- The teacher will distribute and explain Activity 1.2.5 Mechanical System Efficiency (simulation).

- Students will complete Activity 1.2.5 Mechanical System Efficiency (simulation).
- The teacher will collect Activity 1.2.5 Mechanical System Efficiency (simulation) and evaluate it using Activity 1.2.5 Mechanical System Efficiency (simulation) Answer Key.

Also, assign readings from textbook on material as appropriate.

Assessments:

Diagnostic: Warmup Question Responses

Formative: Performance and responses on Activities 1.2.1 through 1.2.5, Quizzes on Textbook reading assignments

Summative: Unit Test

Extensions:

1. Textbook "Extra Mile" Challenges.
2. Additional readings and quizzes from textbook.

Correctives:

1. Additional independent design challenges.
2. More extensive direct instruction and modeling of the work, energy, power, and electrical property calculations.
3. Additional practice worksheets from textbook's workbook.
4. Additional readings and quizzes from textbook.
5. Lesson 1.2 Key Terms Crossword for additional vocabulary practice.

Materials and Resources:

Print Texts: *Principles of Engineering*

Web sites: my.pltw.org for Powerpoints, Activities, and Projects

Other Resources: breadboards and electrical components (LEDs, wires, resistors, multimeters, wire strippers)

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UNIT: 1.3 Energy Applications

Big Idea # 1:

- A technological world requires that humans develop capabilities to solve technological challenges and improve products for the way we live.

Essential Questions:

- How have technological developments impacted devices, processes, and systems for the way we live?

Concepts:

- The abilities required in a technological world include diagnosing, troubleshooting, analyzing and maintaining systems.
- Innovation is the process of modifying an existing product, process, or system to improve it.
- Invention is a process of turning ideas and imagination into new products, processes, or systems.
- Safety is a preeminent concern for all technological development and use.

Competencies:

- Develop the abilities to use and maintain technological products and systems.
- Improve an existing product, process, or system.
- Create a new product, process, or system.
- Safely use tools, machines, and electronic devices.
- Explain the importance of carefully assessing technological inventions and innovations.

Big Idea #2:

- Each area of technology has a set of characteristics that separates it from others; however, many areas overlap in order to meet human needs and wants.

Essential Questions:

- How do various areas of technology influence the economy, the environment, and society?

Concepts:

- Manufacturing is the process of turning raw materials into useful products.
- Energy and power technologies are the processes of converting energy sources into useful power.

Competencies:

- Design and develop the ability to safely and effectively use tools and materials to manufacture products.
- Design and develop the ability to safely and effectively use tools and materials to transport people and products.
- Design and develop the ability to safely and effectively use tools and materials to convert energy into useful power.

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Big Idea # 3:

- Technological design is a creative process that anyone can do which may result in new inventions and innovations.

Essential Questions:

- How would you apply technological design and problem solving methods in the development of inventions and innovations?

Concepts:

- Technological design & problem solving utilizes a series of steps that take place in a well-defined sequence.
- Technological design & problem solving transforms an idea into a final product or system.
- Technological design & problem solving requires the application of hands-on abilities such as sketching, prototyping, and fabricating.
- Technological design & problem solving includes both formative and summative analysis.
- Technological design & problem solving requires the ability to clearly communicate engineered solutions.

Competencies:

- Use design and problem solving skills to solve technological challenges.
- Transform ideas into technological products and/or systems.
- Use hands-on skills to create useful products and solve technological challenges.
- Describe and demonstrate how to use the technological method to analyze technological processes and solutions.
- Clearly communicate engineered solutions in written, spoken, and graphical means.

Big Idea # 4:

- Technology is created, used and modified by humans.

Essential Questions:

- What knowledge and skills are essential for humans to make sound decisions about creating, using, and modifying technologies?

Concepts:

- Decisions about the use of products and systems can result in known and unexpected consequences.
- The study of the impacts of technological systems enables us to plan and direct technological developments.
- The use of technology involves weighing the trade-offs of the positive and negative effects.
- Science is the study of the natural world and technology is the study of the human designed world but both are inextricably connected.
- Human decision making (e.g. Human needs and wants plus cultural considerations) drives the selection and/or use of technologies.
- Creating optimal solutions under constraints are a primary component of technological problem solving (e.g., tools/machines, materials, information, people, capital, energy, and time).

Competencies:

- Explain how making informed decisions about the development and use of technology may have known and unexpected consequences.
- Describe the nature of technology and the consequences of technological activity which impact society and the world.
- Explain how technology has and can change the human condition throughout time.
- Differentiate between the study of science and technology.
- Describe the complementary roles of scientific knowledge and technological application.
- Demonstrate how technological progress promotes the advancement of science, technology, engineering and mathematics (STEM).
- Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness and the ability to visualize and think abstractly.

Big Idea # 5:

- Technological literacy is the ability to use, assess and manage technology around us.

Essential Questions:

- What is technological literacy?

Concepts:

- Technology and society mutually impact each other.
- Technological literacy is the ability to understand, use, assess, design, and produce technology (i.e. Invention & Innovation).
- Technological literacy is required for all citizens in a democratic society for shared decision-making.
- Technological literacy is necessary for a productive 21st century skilled workforce.
- People select, create, and use science and technology and are limited by constraints (e.g. social and physical).

Competencies:

- Describe how technological development impacts economics, culture, and policies.
- Design and produce solutions to technological problems.
- Recognize the importance of using technological knowledge to participate competently in a democratically society.
- Develop skills for a 21st century workforce.
- Recognize technological literacy as a necessary lifetime endeavor which requires additional knowledge and information.
- Compare and contrast the natural constraints imposed on scientific and technological change.

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Curriculum Plan

Unit 1.3 Energy Applications **Time Range in Days: 10-13**

Standard(s): PA Academic Standards, PACCS Reading and Writing for Science and Technology

Standards Addressed: (Number Only- See Appendix for Description)
PA Academic Standards: 3.4.10.A1, 3.4.10.A2, 3.4.10.A3, 3.4.12.A.1, 3.4.10.B1, 3.4.10.B2, 3.4.10.B3, 3.4.10.B4, 3.4.12.B1, 3.4.12.B2, 3.4.10.C1, 3.4.10.C2, 3.4.12.C2, 3.4.12.C3, 3.4.10.D1, 3.4.10.D2, 3.4.10.D3, 3.4.12.D2, 3.4.10.E3, 3.4.10.E5, 3.4.12.E2, 3.4.12.E3, 3.4.12.E5, 3.4.12.E6

PACCS: CC.3.5.9-10.A, CC.3.5.9-10.B, CC.3.5.9-10.C, CC.3.5.9-10.D, CC.3.5.9-10.J, CC.3.5.9-10.E CC.3.6.9-10.A., CC.3.6.9-10.B., CC.3.6.9-10.C., CC.3.6.9-10.E, CC.3.6.9-10.F, CC.3.6.9-10.G, CC.3.6.9-10.H, CC.3.6.9-10.I.

Anchor(s): S8.A.1.1, S8.A.1.2, S8.A.1.3, S8.A.2.1, S8.C.2.1, S8.C.2.2, S8D.1.2, S11.A.1.1, S11.A.1.2, S11.A.1.3, S11.A.2.1, S11.A.2.2, S11.A.3.1, S11.A.3.2, S11.A.3.3, S11.B.1.1, S11.B.3.2, S11.B.3.3, S11.C.1.1, S11.C.2.1, S11.C.2.2, S11.C.3.1, S11.D.1.2

Overview: Thermodynamic concepts allow engineers to explain and quantify how energy is transferred and how it moves through physical systems.

Focus Question(s): 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?

Goals: It is expected that students will:

- 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.

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Objectives:

(Include DOK Levels)

1. Students shall be able to categorize energy sources as nonrenewable, renewable, or inexhaustible. (DOK Level 2)
2. Students shall have a basic understanding of how electrical power is produced and distributed in their geographical area. (DOK Level 1)
3. Students shall be able to construct and mathematically analyze basic electrical circuits. (DOK Level 4)
4. Students shall understand the engineering terms “work”, “energy” and “power” and calculate these properties for real world situations. (DOK Level 4)
5. Students shall construct an electro-mechanical device and mathematically analyze its capabilities and performance. (DOK Level 4)

Core Activities and Corresponding Instructional Methods:

Part 1:

- **Direct Instruction and Cooperative Learning**
- The teacher will present Concepts, Key Terms, and Essential Questions to provide a lesson overview.
- The teacher will present Hydrogen Fuel Cell.ppt.
- Students will take notes during the presentation in their journals.
- The teacher will distribute and introduce Activity 1.3.1 Solar Hydrogen System (FT).
- The teacher will distribute and introduce Activity 1.3.1a Solar Hydrogen Automobile (FT) build instructions.

Parts 2 – 4:

- **Cooperative Learning**
- Student teams will complete the Activity 1.3.1a Solar Hydrogen Automobile.
- Students will complete Activity 1.3.1 Solar Hydrogen System.

Parts 5 – 6:

- **Direct Instruction**
- The teacher will distribute and introduce Activity 1.3.3 Thermodynamics.
- The teacher will present Introduction to Thermodynamics.ppt.
- Students will take notes during the presentation in their journals.
- Student will complete Activity 1.3.3 Thermodynamics.

Parts 7-10:

- **Cooperative Learning**

- The teacher will distribute and introduce Project 1.3.4 Renewable Insulation and Project 1.3.4 Renewable Insulation Rubric.
- The teacher will place students into teams of two.
- Student teams will design, construct, and test recyclable house insulation.
- Students must maintain a spreadsheet for the cost of insulation material, including all wasted material.
- Student teams will create a Product Development Lifecycle for the insulation material selected as homework, if necessary.
- Student teams will prepare a spreadsheet for the material cost of the house insulation as homework, if necessary.
- The teacher will assess student teams using Project 1.3.4 Renewable Insulation Rubric.

Also, assign readings from textbook on material as appropriate.

Assessments:

Diagnostic: Warmup Question Responses

Formative: Performance and responses on Activities 1.3.1 through 1.3.3, Quizzes on Textbook reading assignments

Summative: Project 1.3.4, Unit Test

Extensions:

1. Textbook "Extra Mile" Challenges.
2. Additional readings and quizzes from textbook.

Correctives:

1. Additional independent design challenges.
2. More extensive direct instruction and modeling of thermodynamic calculations.
3. Additional practice worksheets from textbook's workbook.
4. Additional readings and quizzes from textbook.
5. Lesson 1.3 Key Terms Crossword for additional vocabulary practice.

Materials and Resources:

Print Texts: *Principles of Engineering*

Web sites: my.pltw.org for Powerpoints, Activities, and Projects

Other Resources: fischertechnik kits with fuel cells and solar cells, distilled water, recyclable insulating material.

DELAWARE VALLEY SCHOOL DISTRICT

UNIT: 1.4 Design Challenge: Energy and Power

Big Idea # 1:

- A technological world requires that humans develop capabilities to solve technological challenges and improve products for the way we live.

Essential Questions:

- How have technological developments impacted devices, processes, and systems for the way we live?

Concepts:

- The abilities required in a technological world include diagnosing, troubleshooting, analyzing and maintaining systems.
- Innovation is the process of modifying an existing product, process, or system to improve it.
- Invention is a process of turning ideas and imagination into new products, processes, or systems.
- Safety is a preeminent concern for all technological development and use.

Competencies:

- Develop the abilities to use and maintain technological products and systems.
- Improve an existing product, process, or system.
- Create a new product, process, or system.
- Safely use tools, machines, and electronic devices.
- Explain the importance of carefully assessing technological inventions and innovations.

Big Idea #2:

- Each area of technology has a set of characteristics that separates it from others; however, many areas overlap in order to meet human needs and wants.

Essential Questions:

- How do various areas of technology influence the economy, the environment, and society?

Concepts:

- Energy and power technologies are the processes of converting energy sources into useful power.

Competencies:

- Design and develop the ability to safely and effectively use tools and materials to convert energy into useful power.

Big Idea # 3:

- Technological design is a creative process that anyone can do which may result in new inventions and innovations.

Essential Questions:

- How would you apply technological design and problem solving methods in the development of inventions and innovations?

Concepts:

- Technological design & problem solving utilizes a series of steps that take place in a well-defined sequence.
- Technological design & problem solving transforms an idea into a final product or system.
- Technological design & problem solving requires the application of hands-on abilities such as sketching, prototyping, and fabricating.
- Technological design & problem solving includes both formative and summative analysis.
- Technological design & problem solving requires the ability to clearly communicate engineered solutions.

Competencies:

- Use design and problem solving skills to solve technological challenges.
- Transform ideas into technological products and/or systems.
- Use hands-on skills to create useful products and solve technological challenges.
- Describe and demonstrate how to use the technological method to analyze technological processes and solutions.
- Clearly communicate engineered solutions in written, spoken, and graphical means.

Big Idea # 4:

- Technology is created, used and modified by humans.

Essential Questions:

- What knowledge and skills are essential for humans to make sound decisions about creating, using, and modifying technologies?

Concepts:

- Decisions about the use of products and systems can result in known and unexpected consequences.
- The study of the impacts of technological systems enables us to plan and direct technological developments.
- The use of technology involves weighing the trade-offs of the positive and negative effects.
- Science is the study of the natural world and technology is the study of the human designed world but both are inextricably connected.
- Human decision making (e.g. Human needs and wants plus cultural considerations) drives the selection and/or use of technologies.
- Creating optimal solutions under constraints are a primary component of technological problem solving (e.g., tools/machines, materials, information, people, capital, energy, and time).

Competencies:

- Explain how making informed decisions about the development and use of technology may have known and unexpected consequences.
- Describe the nature of technology and the consequences of technological activity which impact society and the world.

- Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness and the ability to visualize and think abstractly.

Big Idea # 5:

- Technological literacy is the ability to use, assess and manage technology around us.

Essential Questions:

- What is technological literacy?

Concepts:

- Technology and society mutually impact each other.
- Technological literacy is the ability to understand, use, assess, design, and produce technology (i.e. Invention & Innovation).
- Technological literacy is required for all citizens in a democratic society for shared decision-making.
- Technological literacy is necessary for a productive 21st century skilled workforce.
- People select, create, and use science and technology and are limited by constraints (e.g. social and physical).

Competencies:

- Describe how technological development impacts economics, culture, and policies.
- Design and produce solutions to technological problems.
- Recognize the importance of using technological knowledge to participate competently in a democratically society.
- Develop skills for a 21st century workforce.
- Compare and contrast the natural constraints imposed on scientific and technological change.

DELAWARE VALLEY SCHOOL DISTRICT

Curriculum Plan

Unit 1.4 Design Challenge: Energy and Power **Time Range in Days: 10-11**

Standard(s): PA Academic Standards, PACCS Reading and Writing for Science and Technology

Standards Addressed: (Number Only- See Appendix for Description)
PA Academic Standards: 3.4.10.A1, 3.4.10.A2, 3.4.12.A.2, 3.4.10.B1, 3.4.10.B2, 3.4.10.B3, 3.4.12.B1, 3.4.12.B2, 3.4.10.C1, 3.4.10.C2, 3.4.12.C2, 3.4.12.C3, 3.4.10.D1, 3.4.10.D2, 3.4.10.D3, 3.4.12.D2, 3.4.10.E3, 3.4.12.E2, 3.4.12.E3, 3.4.12.E6

PACCS: CC.3.5.9-10.A, CC.3.5.9-10.B, CC.3.5.9-10.C, CC.3.5.9-10.D, CC.3.5.9-10.J, CC.3.5.9-10.E CC.3.6.9-10.A., CC.3.6.9-10.B., CC.3.6.9-10.C., CC.3.6.9-10.E, CC.3.6.9-10.F, CC.3.6.9-10.G, CC.3.6.9-10.H, CC.3.6.9-10.I.

Anchor(s): S8.A.1.1, S8.A.1.2, S8.A.1.3, S8.A.2.1, S8.A.2.2, S8.C.2.1, S8.C.2.2, S8D.1.2, S11.A.1.2, S11.A.1.3, S11.A.2.1, S11.A.2.2, S11.A.3.1, S11.A.3.2, S11.A.3.3, S11.B.1.1, S11.B.3.2, S11.B.3.3, S11.C.2.1, S11.C.2.2, S11.D.1.2

Overview: Engineers use knowledge of energy generation and energy transport to solve problems.

Focus Question(s): What is a design brief and what are design constraints? Why is a design process so important to follow when creating a solution to a problem? What is a decision matrix and why is it used? What does consensus mean, and how do teams use consensus to make decisions?

Goals: It is expected that students will:

- Brainstorm and sketch possible solutions to an existing design problem.
- Create a decision making matrix for their design problem.
- Select an approach that meets or satisfies the constraints provided in a design brief.
- Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon the design team's decision matrix.
- Present a workable solution to the design problem.

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Objectives:

(Include DOK Levels)

1. Students shall be able to prepare a design brief given a description of an engineering problem. (DOK Level 2)
2. Students shall work in a team to solve an engineering problem. (DOK Level 4)
3. Students shall apply the engineering design process to an engineering problem. (DOK Level 4)
4. Students shall utilize a decision matrix to choose the best potential solution to an engineering design problem. (DOK Level 4)
5. Students shall construct a model of an electrical power grid with various renewable energy sources feeding the grid. (DOK Level 4)

Core Activities and Corresponding Instructional Methods:

Parts 1-2:

- **Direct Instruction**
- The teacher will present Concepts, Key Terms, and Essential Questions to provide a lesson overview.
- The teacher will review the Professional Interview activity assigned in Lesson 1.1 Mechanisms.
- The teacher will present Introduction to Design Briefs.ppt. Students will take notes in their journals.
- The teacher will divide the class into teams of four.
- The teacher will distribute and introduce Problem 1.4.1 Design Problem (FT) and Problem 1.4.1 Design Problem Rubric (FT).
- The teacher will present Teamwork.ppt. Students will take notes in their journals.
- The teacher will review the design process used in this course by presenting Design Process Overview.ppt.
- Students will take notes during the presentation in their journals.
- The teacher will distribute Example Design Process. Students will keep the Example Design Process document available for reference during this lesson.
- The teacher will lead a class discussion to further refine the design statement, add additional constraints, identify available resources, and assign teams and team responsibilities.
- The teacher will present Decision Matrix.ppt. Students will take notes in their journals.
- The teacher will distribute and explain the Decision Matrix Template.
- The teacher will distribute and discuss Design Modifications Chart and Citations in APA Style.

Parts 3-13:

- **Cooperative Learning**
- Students will continue working on deliverables to be completed for Problem 1.4.1 Design Problem.
- The teacher will keep students on task and answer any questions during the process.
- Students will complete Problem 1.4.1 Design Problem.
- Students will demonstrate their solution to the class.
- The teacher will assess students using Decision Matrix Rubric and Design Problem Rubric.

Also, assign readings from textbook on material as appropriate.

Assessments:

Diagnostic: Warmup Question Responses

Formative: Quizzes on Textbook reading assignments

Summative: Project 1.4.1

Extensions:

1. Textbook "Extra Mile" Challenges.
2. Additional readings and quizzes from textbook.

Correctives:

1. Additional independent design challenges.
2. Additional readings and quizzes from textbook.
3. Additional practice worksheets from textbook's workbook.
4. Lesson 1.4 Key Terms Crossword for additional vocabulary practice.

Materials and Resources:

Print Texts: *Principles of Engineering*

Web sites: my.pltw.org for Powerpoints, Activities, and Projects

Other Resources: fischertechnik kits with fuel cells and solar cells, distilled water, breadboards and electrical components (LEDs, wires, wire strippers, multimeters), box fan.

DELAWARE VALLEY SCHOOL DISTRICT

UNIT: 2.1 Statics

Big Idea # 1:

- A technological world requires that humans develop capabilities to solve technological challenges and improve products for the way we live.

  Essential Questions:
  - How have technological developments impacted devices, processes, and systems for the way we live?

  Concepts:
  - The abilities required in a technological world include diagnosing, troubleshooting, analyzing and maintaining systems.
  - Innovation is the process of modifying an existing product, process, or system to improve it.
  - Invention is a process of turning ideas and imagination into new products, processes, or systems.
  - Safety is a preeminent concern for all technological development and use.

  Competencies:
  - Develop the abilities to use and maintain technological products and systems.
  - Improve an existing product, process, or system.
  - Create a new product, process, or system.
  - Safely use tools, machines, and electronic devices.
  - Explain the importance of carefully assessing technological inventions and innovations.

Big Idea #2:

- Each area of technology has a set of characteristics that separates it from others; however, many areas overlap in order to meet human needs and wants.

  Essential Questions:
  - How do various areas of technology influence the economy, the environment, and society?

  Concepts:
  - Construction is the process of turning raw materials into useful structures.

  Competencies:
  - Design and develop the ability to safely and effectively use tools and materials to build structures.

Big Idea # 3:

- Technological design is a creative process that anyone can do which may result in new inventions and innovations.

Essential Questions:

- How would you apply technological design and problem solving methods in the development of inventions and innovations?

Concepts:

- Technological design & problem solving utilizes a series of steps that take place in a well-defined sequence.
- Technological design & problem solving transforms an idea into a final product or system.
- Technological design & problem solving requires the application of hands-on abilities such as sketching, prototyping, and fabricating.
- Technological design & problem solving includes both formative and summative analysis.
- Technological design & problem solving requires the ability to clearly communicate engineered solutions.

Competencies:

- Use design and problem solving skills to solve technological challenges.
- Transform ideas into technological products and/or systems.
- Use hands-on skills to create useful products and solve technological challenges.
- Describe and demonstrate how to use the technological method to analyze technological processes and solutions.
- Clearly communicate engineered solutions in written, spoken, and graphical means.

Big Idea # 4:

- Technology is created, used and modified by humans.

Essential Questions:

- What knowledge and skills are essential for humans to make sound decisions about creating, using, and modifying technologies?

Concepts:

- Decisions about the use of products and systems can result in known and unexpected consequences.
- The study of the impacts of technological systems enables us to plan and direct technological developments.
- The use of technology involves weighing the trade-offs of the positive and negative effects.
- Science is the study of the natural world and technology is the study of the human designed world but both are inextricably connected.
- Creating optimal solutions under constraints are a primary component of technological problem solving (e.g., tools/machines, materials, information, people, capital, energy, and time).

Competencies:

- Explain how making informed decisions about the development and use of technology may have known and unexpected consequences.
- Describe the nature of technology and the consequences of technological activity which impact society and the world.

- Explain how technology has and can change the human condition throughout time.
- Describe the complementary roles of scientific knowledge and technological application.
- Demonstrate how technological progress promotes the advancement of science, technology, engineering and mathematics (STEM).
- Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness and the ability to visualize and think abstractly.

Big Idea # 5:

- Technological literacy is the ability to use, assess and manage technology around us.

Essential Questions:

- What is technological literacy?

Concepts:

- Technology and society mutually impact each other.
- Technological literacy is the ability to understand, use, assess, design, and produce technology (i.e. Invention & Innovation).
- People select, create, and use science and technology and are limited by constraints (e.g. social and physical).

Competencies:

- Describe how technological development impacts economics, culture, and policies.
- Design and produce solutions to technological problems.
- Develop skills for a 21st century workforce.
- Compare and contrast the natural constraints imposed on scientific and technological change.

DELAWARE VALLEY SCHOOL DISTRICT

Curriculum Plan

Unit 2.1 Statics **Time Range in Days: 18-19**

Standard(s): PA Academic Standards, PACCS Reading and Writing for Science and Technology

Standards Addressed: (Number Only- See Appendix for Description)
PA Academic Standards: 3.4.10.A1, 3.4.10.A2, 3.4.10.B1, 3.4.12.B1, 3.4.12.B2, 3.4.10.C1, 3.4.10.C2, 3.4.12.C2, 3.4.10.D1, 3.4.10.D2, 3.4.10.D3, 3.4.12.D2, 3.4.12.E7

PACCS: CC.3.5.9-10.A, CC.3.5.9-10.B, CC.3.5.9-10.C, CC.3.5.9-10.D, CC.3.5.9-10.J, CC.3.5.9-10.E CC.3.6.9-10.A., CC.3.6.9-10.B., CC.3.6.9-10.C., CC.3.6.9-10.E, CC.3.6.9-10.F, CC.3.6.9-10.G, CC.3.6.9-10.H, CC.3.6.9-10.I.

Anchor(s): S8.A.1.1, S8.A.1.2, S8.A.1.3, S8.A.2.1, S8.A.2.2, S11.A.1.2, S11.A.1.3, S11.A.2.1, S11.A.2.2, S11.A.3.1, S11.A.3.2, S11.A.3.3, S11.B.1.1, S11.B.3.2

Overview: Statics concepts allow engineers to design structures that are in static (not moving) equilibrium.

Focus Question(s): 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?

Goals: It is expected that students will:

- 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.

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Objectives:

(Include DOK Levels)

1. Students shall research their chosen field of engineering and prepare a written report that describes it. (DOK Level 2)
2. Students shall be able to calculate and experimentally determine centroids of 2 dimensional shapes. (DOK Level 4)
3. Students shall be able to calculate and experimentally determine moments and inertia and deflection under load for rectangular shapes. (DOK Level 4)
4. Students shall be able to construct free body diagram of real world objects. (DOK Level 3)
5. Students shall be able to mathematically resolve force vectors into components. (DOK Level 2)
6. Students shall be able to calculate and experimentally determine bending moments. (DOK Level 4)
7. Students shall be able to calculate weak points in a simple truss and check their predictions experimentally. (DOK Level 4)

Core Activities and Corresponding Instructional Methods:

Part 1:

- **Direct Instruction**
- The teacher will distribute and explain Career Field Description and Career Field Description Rubric.
- The teacher will lead a discussion about how to obtain information relating to engineering and engineering technology career fields. Students will be given a due date for the activity to be completed and submitted.
- The teacher will present Concepts, Key Terms, and Essential Questions to provide a lesson overview.
- The teacher will deliver Introduction to Statics.ppt.
- Students will take notes during the presentation in their journals.

Part 2:

- **Direct Instruction and Independent Practice**
- The teacher will deliver Centroids.ppt.
- Students will take notes during the presentation in their journals.
- The teacher will distribute, explain, and assign Activity 2.1.1 Centroids.

Part 3:

- **Direct Instruction and Independent Practice**
- The teacher will review and collect Activity 2.1.1 Centroids.
- The teacher will deliver Introduction To Structural Member Properties.ppt

- Students will take notes during the presentation in their journals.
- The teacher will distribute Activity 2.1.2 Beam Deflection.
- Students will complete Activity 2.1.2 Beam Deflection while the teacher leads the class through the activity.
- Students will complete Activity 2.1.2 Beam Deflection calculations and conclusion questions individually for homework.

Part 4:

- **Direct Instruction and Independent Practice**
- The teacher will review and collect Activity 2.1.2 Beam Deflection.
- The teacher will deliver Free Body Diagrams.ppt.
- Students will take notes during the presentation in their journals.
- The teacher will distribute, explain, and assign Activity 2.1.3 Free Body Diagrams.

Part 5:

- **Direct Instruction and Independent Practice**
- The teacher will review and collect Activity 2.1.3 Free Body Diagrams.
- The teacher will deliver Force Vectors.ppt.
- Students will take notes during the presentation in their journals.
- The teacher will distribute, explain, and assign Activity 2.1.4 Calculating Force Vectors.

Part 6:

- **Direct Instruction and Independent Practice**
- The teacher will review and collect Activity 2.1.4 Calculating Force Vectors.
- The teacher will deliver Moments.ppt.
- Students will take notes during the presentation in their journals.
- The teacher will distribute Activity 2.1.5 Calculating Moments.
- Students will complete Activity 2.1.5 Calculating Moments while the teacher leads the class through the activity.
- Students will complete Activity 2.1.5 Calculating Moments calculations and conclusion questions individually for homework.

Part 7:

- **Direct Instruction and Independent Practice**
- The teacher will review and collect Activity 2.1.5 Calculating Moments.
- The teacher will deliver Calculating Truss Forces.ppt.
- Students will take notes during the presentation in their journals.
- The teacher will distribute and explain Activity 2.1.6 Step-by-Step Truss System.
- The teacher will begin the activity by guiding students through the activity procedure and steps.

Part 8:

- **Direct Instruction and Independent Practice**
- Students will continue to work on Activity 2.1.6 Step-by-Step Truss System.
- The teacher will review and collect Activity 2.1.6 Step-by-Step Truss System.
- The teacher will distribute and explain Activity 2.1.7 Calculating Truss Forces.

Part 9:

- **Cooperative Learning**
- The teacher will distribute Project 2.1.8 Truss Design (SSA), and students in teams of two or three will build trusses as outlined in the activity and test them the following day using the SSA and matching Truss Testing device.
- Students will allow their trusses to dry before the next class session.
- Students will continue work on Activity 2.1.7 Calculating Truss Forces while the instructor provides necessary guidance.

Part 10:

- **Cooperative Learning**
- Students will test their truss designs and complete required documentation in their engineering journals.
- As teams take turns testing their designs, students will continue work on Activity 2.1.7 Calculating Truss Forces. The instructor will provide necessary guidance.

Part 11:

- **Cooperative Learning**
- The teacher will lead a discussion to define the constraints and expectations for the Truss Design Challenge portion of Project 2.1.8 Truss Design.
- Students will record the necessary information in their engineering notebooks.
- Students will begin designing and evaluating their design ideas.
- Students will complete the calculations for Activity 2.1.7 Calculating Truss Forces as homework.

Parts 12 - 14:

- **Cooperative Learning**
- The teacher will review and collect Project 2.1.8 Calculating Truss Forces.
- Students will finish designing, building, testing, and preparing documentation for the Truss Design Challenge portion of Project 2.1.8 Truss Design.

Also, assign readings from textbook on material as appropriate.

Assessments:

Diagnostic: Warmup Question Responses

Formative: Performance and responses on Activities 2.1.1 through 2.1.7, Quizzes on Textbook reading assignments

Summative: Project 2.1.8, Unit Test

Extensions:

1. Textbook "Extra Mile" Challenges.
2. Additional readings and quizzes from textbook.

Correctives:

1. Additional independent design challenges.
2. Additional readings and quizzes from textbook.
3. Additional practice worksheets from textbook's workbook.
4. Lesson 2.1 Key Terms Crossword for additional vocabulary practice.
5. Supplemental instructional packet on truss calculations.
6. MDSolids Animated Learning Tools on centroids and moment of inertia.

Materials and Resources:

Print Texts: *Principles of Engineering*

Web sites: my.pltw.org for Powerpoints, Activities, and Projects

Other Resources: SSA with Truss Tester, 1/8" balsa wood sticks and glue, balsa wood cutters, drying boards.

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UNIT: 2.2 Material Properties

Big Idea # 1:

- A technological world requires that humans develop capabilities to solve technological challenges and improve products for the way we live.

  Essential Questions:
  - How have technological developments impacted devices, processes, and systems for the way we live?

  Concepts:
  - The abilities required in a technological world include diagnosing, troubleshooting, analyzing and maintaining systems.
  - Innovation is the process of modifying an existing product, process, or system to improve it.
  - Invention is a process of turning ideas and imagination into new products, processes, or systems.
  - Safety is a preeminent concern for all technological development and use.

  Competencies:
  - Develop the abilities to use and maintain technological products and systems.
  - Improve an existing product, process, or system.
  - Safely use tools, machines, and electronic devices.
  - Explain the importance of carefully assessing technological inventions and innovations.

Big Idea #2:

- Each area of technology has a set of characteristics that separates it from others; however, many areas overlap in order to meet human needs and wants.

  Essential Questions:
  - How do various areas of technology influence the economy, the environment, and society?

  Concepts:
  - Manufacturing is the process of turning raw materials into useful products.

  Competencies:
  - Design and develop the ability to safely and effectively use tools and materials to manufacture products.

Big Idea # 3:

- Technology is created, used and modified by humans.

  Essential Questions:
  - What knowledge and skills are essential for humans to make sound decisions about creating, using, and modifying technologies?

Concepts:

- The use of technology involves weighing the trade-offs of the positive and negative effects.
- Human decision making (e.g. Human needs and wants plus cultural considerations) drives the selection and/or use of technologies.
- Creating optimal solutions under constraints are a primary component of technological problem solving (e.g., tools/machines, materials, information, people, capital, energy, and time).

Competencies:

- Explain how making informed decisions about the development and use of technology may have known and unexpected consequences.
- Describe the nature of technology and the consequences of technological activity which impact society and the world.
- Explain how technology has and can change the human condition throughout time.
- Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness and the ability to visualize and think abstractly.

Big Idea # 4:

- Technological literacy is the ability to use, assess and manage technology around us.

Essential Questions:

- What is technological literacy?

Concepts:

- Technology and society mutually impact each other.
- Technological literacy is the ability to understand, use, assess, design, and produce technology (i.e. Invention & Innovation).
- Technological literacy is necessary for a productive 21st century skilled workforce.
- People select, create, and use science and technology and are limited by constraints (e.g. social and physical).

Competencies:

- Describe how technological development impacts economics, culture, and policies.
- Recognize the importance of using technological knowledge to participate competently in a democratically society.
- Develop skills for a 21st century workforce.
- Compare and contrast the natural constraints imposed on scientific and technological change.

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Curriculum Plan

Unit 2.2 Material Properties **Time Range in Days: 15-18**

Standard(s): PA Academic Standards, PACCS Reading and Writing for Science and Technology

Standards Addressed: (Number Only- See Appendix for Description)
PA Academic Standards: 3.4.10.A1, 3.4.10.A2, 3.4.10.A3, 3.4.10.B3, 3.4.12.B1, 3.4.12.B2, 3.4.10.D3, 3.4.12.E6, 3.4.12.E7

PACCS: CC.3.5.9-10.A, CC.3.5.9-10.B, CC.3.5.9-10.C, CC.3.5.9-10.D, CC.3.5.9-10.J, CC.3.5.9-10.E CC.3.6.9-10.A., CC.3.6.9-10.B., CC.3.6.9-10.C., CC.3.6.9-10.E, CC.3.6.9-10.F, CC.3.6.9-10.G, CC.3.6.9-10.H, CC.3.6.9-10.I.

Anchor(s): S8.A.1.1, S8.A.1.2, S8.A.2.1, S8.D.1.2, S11.A.1.2, S11.A.3.1, S11.A.3.3, S11.B.1.1, S11.D.1.2

Overview: Engineers use material properties in order to select the best material for a specific application.

Focus Question(s): 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? How do the recycling codes and symbols differ from state to state?

Goals: It is expected that students will:

- Investigate specific material properties related to a common household product.
- Conduct investigative non-destructive material property tests on selected common household product including testing for continuity, ferrous metal, hardness, and flexure.
- Calculate weight, volume, mass, density, and surface area of selected common household product
- Identify the manufacturing processes used to create the selected common household product.
- Identify the recycling codes.
- Promote recycling using current media trends.

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Objectives:

(Include DOK Levels)

1. Students shall be able to identify and analyze the materials in a common household appliance or device. (DOK Level 4)
2. Students shall recognize and identify the manufacturing processes used to produce components of common items. (DOK Level 2)
3. Students shall be able to construct a product development life cycle of a common household appliance or device. (DOK Level 4)
4. Students shall identify the recycling codes on common objects and determine their material composition from the code. (DOK Level 1)

Core Activities and Corresponding Instructional Methods:

Part 1:

- **Direct Instruction and Cooperative Learning**
- The teacher will present Concepts, Key Terms, and Essential Questions to provide a lesson overview.
- The teacher will present Introduction to Materials.ppt.
- Students will take notes during the presentation in their journals.
- The teacher will create teams of two to four students.
- The teacher will distribute and explain Activity 2.2.1 Product Analysis.
- Student teams will complete the brainstorming portion of Activity 2.2.1 Product Analysis (Part 1 Steps 1 and 2).
- The teacher will remind students to bring products to the next class meeting.

Part 2:

- **Cooperative Learning**
- The teacher will discuss and explain Part 1, Steps 3 through 8 of Activity 2.2.1 Product Analysis.
- Student teams will complete Part 1, Steps 3 through 8 of Activity 2.2.1 Product Analysis.

Parts 3 – 4:

- **Cooperative Learning**
- The teacher will demonstrate the proper procedure for completing step 9 of Activity 2.2.1 Product Analysis. The teacher will utilize an example of a product component.
- Student teams will work on completing Step 9 of Activity 2.2.1 Product Analysis.
- Students will complete Step 9 of Activity 2.2.1 Product Analysis.

Part 5:

- **Cooperative Learning**
- The teacher will explain Part 2: Modeling of Activity 2.2.1 Product Analysis.
- Students will complete Part 2: Modeling of Activity 2.2.1 Product Analysis.
- Students will complete Activity 2.2.1 for homework, if necessary.
- The teacher will use Drawing Rubric to assess the modeled parts. Each team will model a total of four parts.

Part 6:

- **Direct Instruction**
- The teacher will collect Activity 2.2.1 Product Analysis.
- The teacher will present Introduction to Manufacturing Processes.ppt.
- Students will take notes in their journals.

Part 7:

- **Direct Instruction**
- The teacher will select and show students short videos relating to manufacturing processes.
- The teacher will introduce Activity 2.2.2 Manufacturing Processes.
- Students will complete Activity 2.2.2 Manufacturing Processes as homework, if necessary.

Part 8:

- **Direct Instruction and Independent Practice**
- The teacher will collect Activity 2.2.2 Manufacturing Processes.
- The teacher will introduce Activity 2.2.3 Recycling by presenting Recycling Materials.ppt.
- Students will use Activity 2.2.3a Recycling Facts to document information from the teacher presentation and for Activity 2.2.3 Recycling.
- Student teams will begin Part 2 of Activity 2.2.3 Recycling. Students will finish it as homework, if necessary.

Part 9:

- **Cooperative Learning**
- Student teams will use the Product Development Lifecycle example provided in the Recycling Materials presentation to complete task three of Activity 2.2.3 Recycling.
- Student teams will complete tasks three and four of Activity 2.2.3 Recycling as homework, if necessary.

Parts 10 – 11:

- **Cooperative Learning**
- The teacher will collect two Product Development Lifecycles per team and assess for completion of all steps.

- The teacher will collect Activity 2.2.3a Recycling and assess using Activity 2.2.3a Recycling Facts Answer Key.
- Student teams will begin working on task five of Activity 2.2.3 Recycling.
- The teacher will pre-approve student team designs for task five.
- Student teams will complete task five of Activity 2.2.3 Recycling as homework, if necessary.
- The teacher will collect the Conclusion section from each student and assess for completion.
- The teacher will collect and display the sign, cartoon, song, commercial, bumper sticker, t-shirt, or packaging created per team. These items will be assessed using Activity 2.2.3 Recycling Rubric.

Also, assign readings from textbook on material as appropriate.

Assessments:

Diagnostic: Warmup Question Responses

Formative: Performance and responses on Activities 2.2.1 through 2.2.3, Quizzes on Textbook reading assignments

Summative: Unit Test

Extensions:

1. Textbook "Extra Mile" Challenges.
2. Additional readings and quizzes from textbook.

Correctives:

1. Additional independent design challenges.
2. Additional readings and quizzes from textbook.
3. Additional practice worksheets from textbook's workbook.
4. Lesson 2.2 Key Terms Crossword for additional vocabulary practice.
5. The Publishers National Environment Bureau at http://www.pneb.com.au/ has a guided tour of the paper lifecycle. Select the recycling tab to locate the paper lifecycle tour.

Materials and Resources:

Print Texts: *Principles of Engineering*

Web sites: my.pltw.org for Powerpoints, Activities, and Projects

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UNIT: 2.3 Material Testing

Big Idea # 1:

- A technological world requires that humans develop capabilities to solve technological challenges and improve products for the way we live.

  Essential Questions:
  - How have technological developments impacted devices, processes, and systems for the way we live?

  Concepts:
  - The abilities required in a technological world include diagnosing, troubleshooting, analyzing and maintaining systems.
  - Safety is a preeminent concern for all technological development and use.

  Competencies:
  - Safely use tools, machines, and electronic devices.
  - Explain the importance of carefully assessing technological inventions and innovations.

Big Idea # 2:

- Technology is created, used and modified by humans.

  Essential Questions:
  - What knowledge and skills are essential for humans to make sound decisions about creating, using, and modifying technologies?

  Concepts:
  - Decisions about the use of products and systems can result in known and unexpected consequences.
  - The study of the impacts of technological systems enables us to plan and direct technological developments.
  - Science is the study of the natural world and technology is the study of the human designed world but both are inextricably connected.
  - Human decision making (e.g. Human needs and wants plus cultural considerations) drives the selection and/or use of technologies.
  - Creating optimal solutions under constraints are a primary component of technological problem solving (e.g., tools/machines, materials, information, people, capital, energy, and time).

  Competencies:
  - Explain how making informed decisions about the development and use of technology may have known and unexpected consequences.
  - Describe the nature of technology and the consequences of technological activity which impact society and the world.
  - Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness and the ability to visualize and think abstractly.

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Curriculum Plan

Unit 2.3 Material Testing **Time Range in Days: 10-11**

Standard(s): PA Academic Standards, PACCS Reading and Writing for Science and Technology

Standards Addressed: (Number Only- See Appendix for Description)
PA Academic Standards: 3.4.10.A1, 3.4.10.A2, 3.4.12.B2, 3.4.12.C3, 3.4.10.D3, 3.4.10.E7, 3.4.12.E7

PACCS: CC.3.5.9-10.A, CC.3.5.9-10.B, CC.3.5.9-10.C, CC.3.5.9-10.D, CC.3.5.9-10.J, CC.3.5.9-10.E CC.3.6.9-10.A., CC.3.6.9-10.B., CC.3.6.9-10.C., CC.3.6.9-10.E, CC.3.6.9-10.F, CC.3.6.9-10.G, CC.3.6.9-10.H, CC.3.6.9-10.I.

Anchor(s): S8.A.1.1, S8.A.1.2, S8.A.1.3, S8.A.2.1, S8.A.2.2, S11.A.1.1, S11.A.1.2, S11.A.1.3, S11.A.2.1, S11.A.2.2, S11.A.3.1, S11.A.3.2, S11.A.3.3, S11.B.1.1, S11.B.3.2, S11.C.1.1

Overview: Material testing determines the reliability, safety, and functional predictability of a material.

Focus Question(s): 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?

Goals: It is expected that students will:

- Utilize a five-step technique to solve word problems.
- Obtain measurements of material samples.
- Tensile test a material test sample.
- Identify and calculate test sample material properties using a stress strain curve.

Objectives:
(Include DOK Levels)

1. Students shall be able to operate a testing machine to determine the behavior of a material subjected to a tensile force and then interpret the results to make conclusions about the material's capabilities. (DOK Level 4)
2. Students shall be able to calculate the necessary sizes of simple structural shapes given material information and load requirements. (DOK Level 2)

Core Activities and Corresponding Instructional Methods:

Part 1:

- **Direct Instruction**
- The teacher will present Concepts, Key Terms, and Essential Questions to provide a lesson overview.
- The teacher will present Material Testing.ppt.
- Students will take notes during the presentation in their journals.

Parts 2-3:

- **Direct Instruction**
- The teacher will finish presenting Material Testing.ppt.
- Students will continue to take notes in their journals.
- The teacher will distribute Material Testing Formula Sheet.
- The teacher will distribute and provide an overview of Activity 2.3.2 Tensile Testing (SSA).
- The teacher will present Using the Stress Analyzer for Tensile Testing.ppt (SSA).
- The teacher will demonstrate tensile test calculations with an example.
- Students will take notes in their journals.

Part 4:

- **Cooperative Learning**
- The teacher will finish demonstrating Tensile Test calculations.
- Students will begin Activity 2.3.2 Tensile Testing.
- The teacher will distribute electronic copies of Activity 2.3.2 Tensile Testing to students.

Part 5:

- **Independent Practice**
- The teacher will distribute Activity 2.3.1 Stress/Strain Calculations.
- The teacher will distribute Activity 2.3.1a Stress/Strain Calculations Student Worksheet and Material Testing Formula Sheet.
- The teacher will demonstrate calculations for Activity 2.3.1 Stress/Strain Calculations until students are comfortable enough to complete the remainder of problems individually.
- Students can complete the engineering problems using the provided Activity 2.3.1a Stress/Strain Calculations Sheet.

Parts 6-9:

- **Independent Practice**
- During equipment downtime, students will complete Activity 2.3.1 Stress/Strain Calculations.

Part 10:

- **Cooperative Learning and Independent Practice**
- Students will complete Activity 2.3.2 Tensile Testing.
- Students will complete Activity 2.3.1 Stress/Strain Calculations.

Also, assign readings from textbook on material as appropriate.

Assessments:

Diagnostic: Warmup Question Responses

Formative: Performance and responses on Activities 2.3.1 and 2.3.2, Quizzes on Textbook reading assignments

Summative: Unit Test

Extensions:

1. Textbook "Extra Mile" Challenges.
2. Additional readings and quizzes from textbook.

Correctives:

1. Additional independent design challenges.
2. Additional readings and quizzes in textbook.
3. Additional practice worksheets from textbook's workbook.
4. Lesson 2.3 Key Terms Crossword for additional vocabulary practice.

Materials and Resources:

Print Texts: *Principles of Engineering*

Web sites: my.pltw.org for Powerpoints, Activities, and Projects

Other Resources: SSA with Truss Tester, "dogbone" material testing samples.

DELAWARE VALLEY SCHOOL DISTRICT

UNIT: 2.4 Design Challenge: Material and Structures

Big Idea # 1:

- A technological world requires that humans develop capabilities to solve technological challenges and improve products for the way we live.

Essential Questions:

- How have technological developments impacted devices, processes, and systems for the way we live?

Concepts:

- Innovation is the process of modifying an existing product, process, or system to improve it.
- Invention is a process of turning ideas and imagination into new products, processes, or systems.
- Safety is a preeminent concern for all technological development and use.

Competencies:

- Develop the abilities to use and maintain technological products and systems.
- Improve an existing product, process, or system.
- Create a new product, process, or system.
- Safely use tools, machines, and electronic devices.
- Explain the importance of carefully assessing technological inventions and innovations.

Big Idea # 2:

- Technological design is a creative process that anyone can do which may result in new inventions and innovations.

Essential Questions:

- How would you apply technological design and problem solving methods in the development of inventions and innovations?

Concepts:

- Technological design & problem solving utilizes a series of steps that take place in a well-defined sequence.
- Technological design & problem solving transforms an idea into a final product or system.
- Technological design & problem solving requires the application of hands-on abilities such as sketching, prototyping, and fabricating.
- Technological design & problem solving includes both formative and summative analysis.
- Technological design & problem solving requires the ability to clearly communicate engineered solutions.

Competencies:

- Use design and problem solving skills to solve technological challenges.
- Transform ideas into technological products and/or systems.
- Use hands-on skills to create useful products and solve technological challenges.

- Describe and demonstrate how to use the technological method to analyze technological processes and solutions.
- Clearly communicate engineered solutions in written, spoken, and graphical means.

Big Idea # 3:

- Technology is created, used and modified by humans.

Essential Questions:

- What knowledge and skills are essential for humans to make sound decisions about creating, using, and modifying technologies?

Concepts:

- Decisions about the use of products and systems can result in known and unexpected consequences.
- The study of the impacts of technological systems enables us to plan and direct technological developments.
- The use of technology involves weighing the trade-offs of the positive and negative effects.
- Human decision making (e.g. Human needs and wants plus cultural considerations) drives the selection and/or use of technologies.
- Creating optimal solutions under constraints are a primary component of technological problem solving (e.g., tools/machines, materials, information, people, capital, energy, and time).

Competencies:

- Explain how making informed decisions about the development and use of technology may have known and unexpected consequences.
- Describe the nature of technology and the consequences of technological activity which impact society and the world.
- Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness and the ability to visualize and think abstractly.

Curriculum Plan

Unit 2.4 Design Challenge: Materials and Structures **Time Range in Days: 5-6**

Standard(s): PA Academic Standards, PACCS Reading and Writing for Science and Technology

Standards Addressed: (Number Only- See Appendix for Description)

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PA Academic Standards: 3.4.10.A1, 3.4.10.A2, 3.4.10.B1, 3.4.12.B1, 3.4.12.B2, 3.4.10.C1, 3.4.10.C2, 3.4.12.C2, 3.4.12.C3, 3.4.10.D1, 3.4.10.D3, 3.4.12.D2, 3.4.10.E7, 3.4.12.E7

PACCS: CC.3.5.9-10.A, CC.3.5.9-10.B, CC.3.5.9-10.C, CC.3.5.9-10.D, CC.3.5.9-10.J, CC.3.5.9-10.E CC.3.6.9-10.A., CC.3.6.9-10.B., CC.3.6.9-10.C., CC.3.6.9-10.E, CC.3.6.9-10.F, CC.3.6.9-10.G, CC.3.6.9-10.H, CC.3.6.9-10.I.

Anchor(s): S8.A.1.1, S8.A.1.2, S8.A.1.3, S8.A.2.1, S11.A.1.2, S11.A.1.3, S11.A.2.1, S11.A.2.2, S11.A.3.1, S11.A.3.2, S11.A.3.3, S11.B.1.1, S11.B.3.2, S11.C.1.1, S11.C.3.1

Overview: Engineers use information on material properties and material testing to solve practical problems.

Focus Question(s): What is a design brief? What are design constraints? Why is a design process so important to follow when creating a solution to a problem? What is a decision matrix and why is it used? What does consensus mean, and how do teams use consensus to make decisions? How do the properties and types of materials affect the solution to a design problem?

Goals: It is expected that students will:

- Brainstorm and sketch possible solutions to an existing design problem.
- Create a decision making matrix for the design problem.
- Select an approach that meets or satisfies the constraints given in a design brief.
- Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon your team's decision matrix.
- Present a workable design solution.

Objectives:

(Include DOK Levels)

1. Students shall apply the technological design process to a real world engineering problem. (DOK Level 4)
2. Students shall be able to design, with computer assistance, a bridge capable of transporting vehicles and freight over a canyon while considering budget and constructability requirements and constraints. (DOK Level 4)

Core Activities and Corresponding Instructional Methods:

Part 1:

- **Direct Instruction and Cooperative Learning**
- The teacher will review Career Field Description along with Career Field Description Rubric**.**
- The teacher will present any additional Concepts, Key Terms, and Essential Questions to provide an overview.
- The teacher will divide the class into teams of two or three.
- The teacher will distribute and introduce Activity 2.4.1 Structural Design and Design Problem Rubric.
- Students will take notes in their journal.
- The teacher will distribute Example Design Process. Students will keep Example Design Process document available for reference during this lesson.
- Students will begin work on Activity 2.4.1 Design Problem.

Parts 2 – 5:

- **Direct Instruction and Cooperative Learning**
- The teacher will distribute and explain the Decision Matrix Template and Decision Matrix Rubric.
- The teacher will distribute and discuss Design Modifications Chart and Citations in APA Style. Students will continue working on deliverables to be completed for Activity 2.4.1 Design Problem.
- The teacher will keep students on task and answer any questions during the process.
- Students will complete Activity 2.4.1 Design Problem.
- Students will demonstrate their solution to the class.
- The teacher will assess students using Decision Matrix Rubric and Design Problem Rubric.

Also, assign readings from textbook on material as appropriate.

Assessments:

Diagnostic: Warmup Question Responses

Formative: Performance and responses on Activity 2.4.1, Quizzes on Textbook reading assignments

Summative: Unit Test

Extensions:

1. Textbook "Extra Mile" Challenges.
2. Additional readings and quizzes from textbook.

Correctives:

1. Additional independent design challenges.
2. Additional readings and quizzes in textbook.
3. Additional practice worksheets from textbook's workbook.
4. Lesson 2.4 Key Terms Crossword for additional vocabulary practice.
5. Design Process and Teamwork Powerpoints.

Materials and Resources:

Print Texts: *Principles of Engineering*

Web sites: my.pltw.org for Powerpoints, Activities, and Projects

Other Resources: West Point Bridge Builder software.

UNIT: 3.1 Machine Control

Big Idea # 1:

- A technological world requires that humans develop capabilities to solve technological challenges and improve products for the way we live.

  Essential Questions:
  - How have technological developments impacted devices, processes, and systems for the way we live?

Concepts:

- The abilities required in a technological world include diagnosing, troubleshooting, analyzing and maintaining systems.
- Innovation is the process of modifying an existing product, process, or system to improve it.
- Invention is a process of turning ideas and imagination into new products, processes, or systems.
- Safety is a preeminent concern for all technological development and use.

Competencies:

- Develop the abilities to use and maintain technological products and systems.
- Improve an existing product, process, or system.
- Create a new product, process, or system.
- Safely use tools, machines, and electronic devices.
- Explain the importance of carefully assessing technological inventions and innovations.

Big Idea #2:

- Each area of technology has a set of characteristics that separates it from others; however, many areas overlap in order to meet human needs and wants.

Essential Questions:

- How do various areas of technology influence the economy, the environment, and society?

Concepts:

- Communication is the process of composing, sending, and receiving messages through technology.
- Transportation is the process of safely and efficiently moving people and products.
- Energy and power technologies are the processes of converting energy sources into useful power.

Competencies:

- Design and develop the ability to create and transmit messages using technology.
- Design and develop the ability to safely and effectively use tools and materials to transport people and products.
- Design and develop the ability to safely and effectively use tools and materials to convert energy into useful power.

Big Idea # 3:

- Technological design is a creative process that anyone can do which may result in new inventions and innovations.

Essential Questions:

- How would you apply technological design and problem solving methods in the development of inventions and innovations?

Concepts:

- Technological design & problem solving utilizes a series of steps that take place in a well-defined sequence.
- Technological design & problem solving transforms an idea into a final product or system.
- Technological design & problem solving requires the application of hands-on abilities such as sketching, prototyping, and fabricating.
- Technological design & problem solving includes both formative and summative analysis.
- Technological design & problem solving requires the ability to clearly communicate engineered solutions.

Competencies:

- Use design and problem solving skills to solve technological challenges.
- Transform ideas into technological products and/or systems.
- Use hands-on skills to create useful products and solve technological challenges.
- Describe and demonstrate how to use the technological method to analyze technological processes and solutions.
- Clearly communicate engineered solutions in written, spoken, and graphical means.

Big Idea # 4:

- Technology is created, used and modified by humans.

Essential Questions:

- What knowledge and skills are essential for humans to make sound decisions about creating, using, and modifying technologies?

Concepts:

- Decisions about the use of products and systems can result in known and unexpected consequences.
- The use of technology involves weighing the trade-offs of the positive and negative effects.
- Human decision making (e.g. Human needs and wants plus cultural considerations) drives the selection and/or use of technologies.
- Creating optimal solutions under constraints are a primary component of technological problem solving (e.g., tools/machines, materials, information, people, capital, energy, and time).

Competencies:

- Explain how making informed decisions about the development and use of technology may have known and unexpected consequences.
- Describe the nature of technology and the consequences of technological activity which impact society and the world.
- Explain how technology has and can change the human condition throughout time.
- Describe the complementary roles of scientific knowledge and technological application.
- Demonstrate how technological progress promotes the advancement of science, technology, engineering and mathematics (STEM).

- Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness and the ability to visualize and think abstractly.

Big Idea # 5:

- Technological literacy is the ability to use, assess and manage technology around us.

Essential Questions:

- What is technological literacy?

Concepts:

- Technological literacy is the ability to understand, use, assess, design, and produce technology (i.e. Invention & Innovation).
- Technological literacy is required for all citizens in a democratic society for shared decision-making.
- Technological literacy is necessary for a productive 21st century skilled workforce.
- People select, create, and use science and technology and are limited by constraints (e.g. social and physical).

Competencies:

- Describe how technological development impacts economics, culture, and policies.
- Design and produce solutions to technological problems.
- Recognize the importance of using technological knowledge to participate competently in a democratically society.
- Develop skills for a 21st century workforce.
- Recognize technological literacy as a necessary lifetime endeavor which requires additional knowledge and information.
- Compare and contrast the natural constraints imposed on scientific and technological change.

DELAWARE VALLEY SCHOOL DISTRICT

Curriculum Plan

Unit 3.1 Machine Control **Time Range in Days: 17-19**

Standard(s): PA Academic Standards, PACCS Reading and Writing for Science and Technology

Standards Addressed: (Number Only- See Appendix for Description)
PA Academic Standards: 3.4.10.A1, 3.4.10.A2, 3.4.12.A1, 3.4.10.B1, 3.4.10.B4, 3.4.12.B1, 3.4.12.B2, 3.4.10.C1, 3.4.10.C2, 3.4.12.C2, 3.4.12.C3, 3.4.10.D1, 3.4.10.D2, 3.4.10.D3, 3.4.12.D2, 3.4.10.E4, 3.4.12.E4

PACCS: CC.3.5.9-10.A, CC.3.5.9-10.B, CC.3.5.9-10.C, CC.3.5.9-10.D, CC.3.5.9-10.J, CC.3.5.9-10.E CC.3.6.9-10.A., CC.3.6.9-10.B., CC.3.6.9-10.C., CC.3.6.9-10.E, CC.3.6.9-10.F, CC.3.6.9-10.G, CC.3.6.9-10.H, CC.3.6.9-10.I.

Anchor(s): S8.A.1.1, S8.A.1.2, S8.A.1.3, S8.A.2.1, S8.A.2.2, S11.A.1.2, S11.A.1.3, S11.A.2.1, S11.A.2.2, S11.A.3.1, S11.A.3.2, S11.A.3.3, S11.B.1.1, S11.B.3.2, S11.C.1.1, S11.C.3.1

Overview: Mechanical processes are many times controlled by computer software and hardware.

Focus Question(s): 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?

Goals: It is expected that students will:

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

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Objectives:

(Include DOK Levels)

1. Students shall research and discuss the demand, average salaries, and education requirements of their chosen field of engineering. (DOK Level 4)
2. Students shall be able to construct and program a control system using knowledge of inputs, outputs, flowcharts, basic programming, branch and variable functions, and open and closed loop systems. (DOK Level 4)
3. Students shall design, build, and program a device to perform a specified task. (DOK Level 4)

Core Activities and Corresponding Instructional Methods:

Part 1:

- **Direct Instruction and Cooperative Learning**
- The teacher will distribute, explain, and assign Career Demand, Salary, and Education along with Career Demand, Salary, and Education Rubric. Students will complete the activity before the end of the unit. They may work on the activity during class as time allows. Additional work must be completed outside of class.
- The teacher will present Concepts, Key Terms, and Essential Questions to provide a lesson overview.
- The teacher will distribute and explain the Interface Setup (FT) document to help students connect the fischertechnik® interfaces and communicate with the computer.
- The teacher will distribute Activity 3.1.1 Inputs and Outputs (FT).
- In teams of two or three, students will complete Activity 3.1.1 Inputs and Outputs (FT) while the teacher keeps students on task and answers any questions during the process.
- Students will answer the Activity 3.1.1 Inputs and Outputs (FT) conclusion questions individually for homework.

Part 2:

- **Direct Instruction and Cooperative Learning**
- The teacher will review and collect Activity 3.1.1 Inputs and Outputs (FT) from students.
- The teacher will present Creating Flowcharts (FT).
- Students will take notes during the presentation in their journals.
- The teacher will distribute and explain Activity 3.1.2 Flowcharting (FT) and Activity 3.1.2a Flowcharting Guide (FT).

Part 3:

- **Direct Instruction and Cooperative Learning**
- Students will complete Activity 3.1.2 Flowcharting (FT).

- The teacher will review and collect Activity 3.1.2 Flowcharting (FT) from students.
- The teacher will present RoboPro Introduction (FT).
- The teacher will distribute and explain Activity 3.1.3 Basic Programming (FT).
- Students will complete Activity 3.1.3 Basic Programming Design (FT).
- The teacher will keep students on task, answer any questions during the process, and provide feedback for the programs that students are asked to demonstrate.
- Students will answer Activity 3.1.3 Basic Programming (FT) conclusion questions for homework.

Part 4:

- **Direct Instruction and Cooperative Learning**
- The teacher will review and collect Activity 3.1.3 Basic Programming (FT) from students.
- The teacher will distribute and explain Activity 3.1.4 Branch Functions (FT).
- Students will complete Activity 3.1.4 Branch Functions (FT).
- The teacher will keep students on task, answer any questions during the process, and provide feedback for the programs that students are asked to demonstrate.
- Students will answer Activity 3.1.4 Branch Functions (FT) conclusion questions for homework.

Part 5:

- **Direct Instruction and Cooperative Learning**
- The teacher will review and collect Activity 3.1.4 Branch Functions (FT).
- The teacher will distribute and explain Activity 3.1.5 Variable Functions (FT).
- Students will complete Activity 3.1.5 Variable Functions (FT).
- The teacher will keep students on task, answer any questions during the process, and provide feedback for the programs that students are asked to demonstrate.
- Students will answer Activity 3.1.5 Variable Functions (FT) conclusion questions for homework.

Part 6:

- **Direct Instruction and Cooperative Learning**
- The teacher will review and collect Activity 3.1.5 Variable Functions (FT) from students.
- The teacher will distribute and explain Activity 3.1.6 Open and Closed Loop Systems (FT).
- Students will complete Activity 3.1.6 Open and Closed Loop Systems (FT) while the teacher keeps students on task, answers any questions during the process, and provides feedback for the programs that students are asked to demonstrate.
- Students will answer Activity 3.1.6 Open and Closed Loop Systems (FT) conclusion questions for homework.

Part 7:

- **Direct Instruction and Cooperative Learning**
- The teacher will review and collect Activity 3.1.6 Open and Closed Loop Systems from students. The teacher will evaluate student submissions with Activity 3.1.6 Open and Closed Loop Systems Answer Key (FT).
- Students will work on completing all unfinished activities.
- The teacher will distribute and introduce Project 3.1.7 Machine Control Design (FT) and Project 3.1.7 Machine Control Design Rubric (FT).
- The teacher and students will determine groups and problems to be solved for Problem 3.1.7 Machine Control Design.

Parts 8-16:

- **Cooperative Learning**
- Students will design, create, test, demonstrate, and prepare documentation for Project 3.1.7 Machine Control Design.
- The teacher will keep students on task and answer any questions during the process.

Also, assign readings from textbook on material as appropriate.

Assessments:

Diagnostic: Warmup Question Responses

Formative: Performance and responses on Activities 3.1.1 through 3.1.6, Quizzes on Textbook reading assignments

Summative: Project 3.1.7, Unit Test

Extensions:

1. Textbook “Extra Mile” Challenges.
2. Additional readings and quizzes from textbook.

Correctives:

1. Additional independent design challenges.
2. Additional readings and quizzes in textbook.
3. Additional practice worksheets from textbook’s workbook.
4. Lesson 3.1 Key Terms Crossword for additional vocabulary practice.
5. Printout of Creating Flowcharts powerpoint

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Materials and Resources:

Print Texts: *Principles of Engineering*

Web sites: my.pltw.org for Powerpoints, Activities, and Projects

Other Resources: fischertechnik kits and RoboPro software.

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UNIT: 3.2 Fluid Power

Big Idea # 1:

- A technological world requires that humans develop capabilities to solve technological challenges and improve products for the way we live.

Essential Questions:

- How have technological developments impacted devices, processes, and systems for the way we live?

Concepts:

- The abilities required in a technological world include diagnosing, troubleshooting, analyzing and maintaining systems.
- Innovation is the process of modifying an existing product, process, or system to improve it.
- Invention is a process of turning ideas and imagination into new products, processes, or systems.
- Safety is a preeminent concern for all technological development and use.

Competencies:

- Develop the abilities to use and maintain technological products and systems.
- Improve an existing product, process, or system.
- Create a new product, process, or system.
- Safely use tools, machines, and electronic devices.
- Explain the importance of carefully assessing technological inventions and innovations.

Big Idea #2:

- Each area of technology has a set of characteristics that separates it from others; however, many areas overlap in order to meet human needs and wants.

Essential Questions:

- How do various areas of technology influence the economy, the environment, and society?

Concepts:

- Manufacturing is the process of turning raw materials into useful products.
- Construction is the process of turning raw materials into useful structures.
- Energy and power technologies are the processes of converting energy sources into useful power.

Competencies:

- Design and develop the ability to safely and effectively use tools and materials to manufacture products.
- Design and develop the ability to safely and effectively use tools and materials to build structures.

- Design and develop the ability to safely and effectively use tools and materials to convert energy into useful power.

DELAWARE VALLEY SCHOOL DISTRICT

Curriculum Plan

Unit 3.2 Fluid Power **Time Range in Days: 13-14**

Standard(s): PA Academic Standards, PACCS Reading and Writing for Science and Technology

Standards Addressed: (Number Only- See Appendix for Description)
PA Academic Standards: 3.4.10.A1, 3.4.10.A2, 3.4.12.A1, 3.4.10.B1, 3.4.12.B2, 3.4.10.B4, 3.4.12.B1, 3.4.12.B2, 3.4.10.C1, 3.4.10.C2, 3.4.12.C2, 3.4.12.C3, 3.4.10.D1, 3.4.10.D2, 3.4.10.D3, 3.4.12.D2, 3.4.12.E6

PACCS: CC.3.5.9-10.A, CC.3.5.9-10.B, CC.3.5.9-10.C, CC.3.5.9-10.D, CC.3.5.9-10.J, CC.3.5.9-10.E CC.3.6.9-10.A., CC.3.6.9-10.B., CC.3.6.9-10.C., CC.3.6.9-10.E, CC.3.6.9-10.F, CC.3.6.9-10.G, CC.3.6.9-10.H, CC.3.6.9-10.I.

Anchor(s): S8.A.1.1, S8.A.1.2, S8.A.1.3, S8.A.2.1, S8.A.2.2, S8.C.2.1, S11.A.1.1, S11.A.1.2, S11.A.1.3, S11.A.2.1, S11.A.2.2, S11.A.3.1, S11.A.3.2, S11.A.3.3, S11.B.1.1, S11.B.3.2, S11.C.1.1, S11.C.2.1, S11.C.2.2, S11.C.3.1

Overview: Pneumatic and hydraulic fluid power systems are used to power and control many types of mechanisms.

Focus Question(s): What impact does fluid power have on our everyday lives? Can you identify devices or systems that do not use fluid power that might be improved with the use of fluid power? What are similarities and differences of mechanical advantage in simple machines and hydraulic systems? Why are Pascal's Law, the perfect gas laws, Bernoulli's Principle, and other similar rules important to engineers and designers of fluid power systems?

Goals: It is expected that students will:

- 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.
- Distinguish between hydrodynamic and hydrostatic systems.
- Design, create, and test a hydraulic device.
- Design, create, and test a pneumatic device.
- 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.

Objectives:

(Include DOK Levels)

1. Students shall research and analyze a fluid power device and prepare written report about the device. (DOK Level 3)
2. Students shall observe pneumatic and hydraulic devices and identify the device's components. (DOK Level 2)
3. Students shall utilize the principles of fluid power and simple machines to design and construct a hydraulic lift, as well as mathematically analyze its performance. (DOK Level 4)

Core Activities and Corresponding Instructional Methods:

Part 1:

- **Direct Instruction**
- The teacher will present Concepts, Key Terms, and Essential Questions to provide a lesson overview.
- The teacher will deliver Fluid Power Introduction.ppt.
- Students will take notes during the presentation in their journals.

Parts 2-3:

- **Direct Instruction and Cooperative Learning**
- The teacher will distribute and assign Activity 3.2.1 Fluid Power Applications and show Fluid Power Applications Exemplar.ppt.
- The teacher will distribute and explain the Activity 3.2.1 Fluid Power Applications Rubric.
- Students will work in teams to complete Activity 3.2.1 Fluid Power Applications for the duration of the lesson and will deliver their presentations at the conclusion of the lesson. Conclusion questions should be completed individually.

Parts 4-5:

- **Direct Instruction and Cooperative Learning**
- The teacher will present Pneumatic Power.ppt.
- Students will take notes during the presentation in their journals.
- The teacher will reveal the sample pneumatic device to students.
- Students will work on Activity 3.2.2 Pneumatic Demonstration to gather information about the sample pneumatic device.

- The teacher will demonstrate the pneumatic device to students and moderate a student-led discussion of how the device functions and relates to the primary parts of a common pneumatic device.

Parts 6-7:

- **Direct Instruction, Cooperative Learning, and Independent Practice**
- The teacher will present Hydraulic Power.ppt.
- Students will take notes during the presentation in their journals.
- The teacher will reveal the sample hydraulic device to students.
- Students will complete the Activity 3.2.4 Hydraulic Demonstration to gather information about the sample hydraulic device.
- The teacher will demonstrate the hydraulic device to students and moderate a student-led discussion of how the device functions and relates to the primary parts of a common hydraulic device.
- Students will be assigned Fluid Power Practice Problems.

Part 8:

- **Cooperative Learning**
- The teacher will distribute and explain Project 3.2.5 Hydraulic Lift Design and Project 3.2.5 Hydraulic Lift Design Rubric.
- The teacher will give a brief introduction of the hydraulics components that will be used to complete Project 3.2.5 Hydraulic Lift Design.
- Student teams will plan a solution to Project 3.2.5 Hydraulic Lift Design.

Parts 9-14:

- **Cooperative Learning**
- Student teams will complete Project 3.2.5 Hydraulic Lift Design.
- Students will individually complete Project 3.2.5 Hydraulic Lift Design procedure and conclusion questions.
- The teacher will review and collect Fluid Power Practice Problems to assess student competence.
- Students will demonstrate their solutions to Project 3.2.5 Hydraulic Lift Design.

Parts 15:

- **Cooperative Learning**
- Students will present their Activity 3.2.1 Fluid Power Applications presentations to the class and submit deliverables associated with the activity.

Also, assign readings from textbook on material as appropriate.

Assessments:

Diagnostic: Warmup Question Responses

Formative: Performance and responses on Activities 3.2.1 and 3.2.4, Quizzes on Textbook reading assignments

Summative: Project 3.2.5, Unit Test

Extensions:

1. Textbook "Extra Mile" Challenges.
2. Additional readings and quizzes from textbook.
3. 3.2.3 Pneumatic Brake Design with fischertechnik :
    - The teacher will distribute and explain Project 3.2.3 Pneumatic Brake Design (FT) and Project 3.2.3 Pneumatic Brake Design Rubric (FT).
    - The teacher will utilize the fischertechnik® Pneumatic Components (FT) document to explain the role and capabilities of the components to be used to complete Project 3.2.3 Pneumatic Brake Design.
    - Students will work in teams to plan a solution and complete Project 3.2.3 Pneumatic Brake Design.
    - Students will individually complete Project 3.2.3 Pneumatic Brake Design procedure and conclusion questions.
    - Students will demonstrate their solutions to Project 3.2.3 Pneumatic Brake Design.
    - The teacher may also want to distribute Example Pneumatic Compressor Design (FT) document if students are having a difficult time with the compressor design portion of Project 3.2.3.

Correctives:

1. Additional independent design challenges.
2. Additional readings and quizzes in textbook.
3. Additional practice worksheets from textbook's workbook.
4. Lesson 3.2 Key Terms Crossword for additional vocabulary practice.

Materials and Resources:

Print Texts: *Principles of Engineering*

Web sites: my.pltw.org for Powerpoints, Activities, and Projects

Other Resources: fischertechnik kits, demonstration hydraulic and pneumatic devices, hydraulic system components (mounting board, clamps, tubing, syringes, weights, drills, screws).

DELAWARE VALLEY SCHOOL DISTRICT

UNIT: 3.3 Design Challenge: Control Systems

Big Idea # 1:

- A technological world requires that humans develop capabilities to solve technological challenges and improve products for the way we live.

Essential Questions:

- How have technological developments impacted devices, processes, and systems for the way we live?

Concepts:

- The abilities required in a technological world include diagnosing, troubleshooting, analyzing and maintaining systems.
- Innovation is the process of modifying an existing product, process, or system to improve it.
- Invention is a process of turning ideas and imagination into new products, processes, or systems.
- Safety is a preeminent concern for all technological development and use.

Competencies:

- Develop the abilities to use and maintain technological products and systems.
- Improve an existing product, process, or system.
- Create a new product, process, or system.
- Safely use tools, machines, and electronic devices.
- Explain the importance of carefully assessing technological inventions and innovations.

Big Idea #2:

- Each area of technology has a set of characteristics that separates it from others; however, many areas overlap in order to meet human needs and wants.

Essential Questions:

- How do various areas of technology influence the economy, the environment, and society?

Concepts:

- Communication is the process of composing, sending, and receiving messages through technology.
- Energy and power technologies are the processes of converting energy sources into useful power.

Competencies:

- Design and develop the ability to create and transmit messages using technology.
- Design and develop the ability to safely and effectively use tools and materials to convert energy into useful power.

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Big Idea # 3:

- Technological design is a creative process that anyone can do which may result in new inventions and innovations.

Essential Questions:

- How would you apply technological design and problem solving methods in the development of inventions and innovations?

Concepts:

- Technological design & problem solving utilizes a series of steps that take place in a well-defined sequence.
- Technological design & problem solving transforms an idea into a final product or system.
- Technological design & problem solving requires the application of hands-on abilities such as sketching, prototyping, and fabricating.
- Technological design & problem solving includes both formative and summative analysis.
- Technological design & problem solving requires the ability to clearly communicate engineered solutions.

Competencies:

- Use design and problem solving skills to solve technological challenges.
- Transform ideas into technological products and/or systems.
- Use hands-on skills to create useful products and solve technological challenges.
- Describe and demonstrate how to use the technological method to analyze technological processes and solutions.
- Clearly communicate engineered solutions in written, spoken, and graphical means.

Big Idea # 4:

- Technology is created, used and modified by humans.

Essential Questions:

- What knowledge and skills are essential for humans to make sound decisions about creating, using, and modifying technologies?

Concepts:

- Decisions about the use of products and systems can result in known and unexpected consequences.
- The use of technology involves weighing the trade-offs of the positive and negative effects.
- Human decision making (e.g. Human needs and wants plus cultural considerations) drives the selection and/or use of technologies.
- Creating optimal solutions under constraints are a primary component of technological problem solving (e.g., tools/machines, materials, information, people, capital, energy, and time).

Competencies:

- Explain how making informed decisions about the development and use of technology may have known and unexpected consequences.
- Describe the nature of technology and the consequences of technological activity which impact society and the world.
- Explain how technology has and can change the human condition throughout time.
- Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness and the ability to visualize and think abstractly.

Big Idea # 5:

- Technological literacy is the ability to use, assess and manage technology around us.

Essential Questions:

- What is technological literacy?

Concepts:

- Technology and society mutually impact each other.
- Technological literacy is the ability to understand, use, assess, design, and produce technology (i.e. Invention & Innovation).
- Technological literacy is required for all citizens in a democratic society for shared decision-making.
- Technological literacy is necessary for a productive 21st century skilled workforce.
- People select, create, and use science and technology and are limited by constraints (e.g. social and physical).

Competencies:

- Describe how technological development impacts economics, culture, and policies.
- Design and produce solutions to technological problems.
- Recognize the importance of using technological knowledge to participate competently in a democratically society.
- Develop skills for a 21st century workforce.
- Compare and contrast the natural constraints imposed on scientific and technological change.

DELAWARE VALLEY SCHOOL DISTRICT

Curriculum Plan

Unit 3.3 Design Challenge: Control Systems **Time Range in Days: 15-16**

Standard(s): PA Academic Standards, PACCS Reading and Writing for Science and Technology

Standards Addressed: (Number Only- See Appendix for Description)
PA Academic Standards: 3.4.10.A1, 3.4.10.A2, 3.4.10.A.3, 3.4.10.B1, 3.4.10.B2, 3.4.12.B1, 3.4.12.B2, 3.4.10.C1, 3.4.10.C2, 3.4.12.C2, 3.4.12.C3, 3.4.10.D1, 3.4.10.D2, 3.4.10.D3, 3.4.12.D2, 3.4.10.E4, 3.4.12.E4

PACCS: CC.3.5.9-10.A, CC.3.5.9-10.B, CC.3.5.9-10.C, CC.3.5.9-10.D, CC.3.5.9-10.J, CC.3.5.9-10.E CC.3.6.9-10.A., CC.3.6.9-10.B., CC.3.6.9-10.C., CC.3.6.9-10.E, CC.3.6.9-10.F, CC.3.6.9-10.G, CC.3.6.9-10.H, CC.3.6.9-10.I.

Anchor(s): S8.A.1.1, S8.A.1.2, S8.A.1.3, S8.A.2.1, S8.D.1.2, S11.A.1.2, S11.A.1.3, S11.A.2.1, S11.A.2.2, S11.A.3.1, S11.A.3.2, S11.A.3.3, S11.B.1.1, S11.B.3.2, S11.B.3.3, S12.D.1.2

Overview: Engineers build mechanical devices and electronic control systems to solve practical problems.

Focus Question(s): What is a design brief and what are design constraints? Why is a design process so important to follow when creating a solution to a problem? What is a decision matrix and why is it used? What does consensus mean, and how do teams use consensus to make decisions? How does the use of mechanisms affect the overall solution to a design problem?

Goals: It is expected that students will:

- Brainstorm and sketch possible solutions to an existing design problem.
- Create a decision-making matrix for their design problem.
- Select an approach that meets or satisfies the constraints provided in a design brief.
- Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon the design team's decision matrix.
- Present a workable solution to the design problem.

Objectives:
(Include DOK Levels)

1. Students shall apply the technological design process to a real world engineering problem. (DOK Level 4)
2. Students shall be able to design and build a device to automatically sort marbles of different sizes and materials and place them in appropriate containers, while considering budget and constructability requirements and constraints. (DOK Level 4)

Core Activities and Corresponding Instructional Methods:

Parts 1 – 2:

- **Direct Instruction and Cooperative Learning**
- The teacher will review Career Demand, Salary, and Education along with Career Demand, Salary, and Education Rubric. Students will complete the activity before the end of the unit.
- The teacher will present Concepts, Key Terms, and Essential Questions to provide a lesson overview.
- The teacher will divide the class into teams of two or three.
- The teacher will distribute and introduce Problem 3.3.1 Design Problem and Design Problem Rubric.
- The teacher will review the design process used in this course by presenting Design Process Overview.ppt.
- Students will take notes during the presentation in their journals.

Parts 3 – 15:

- **Cooperative Learning**
- The teacher will distribute and explain the Decision Matrix Template.
- The teacher will distribute and discuss Design Modifications Chart and Citations in APA Style.
- Students will continue working on deliverables to be completed for Problem 3.3.1 Design Problem.
- The teacher will keep students on task and answer any questions during the process.
- Students will complete Problem 3.3.1 Design Problem.
- Students will demonstrate their solution to the class.
- The teacher will assess students using Decision Matrix Rubric and Design Problem Rubric.

Also, assign readings from textbook on material as appropriate.

Assessments:

Diagnostic: Warmup Question Responses

Formative: Quizzes on Textbook reading assignments

Summative: Project 3.3.1, Unit Test

Extensions:

1. Textbook "Extra Mile" Challenges.
2. Additional readings and quizzes from textbook.

Correctives:

1. Additional independent design challenges.
2. Additional readings and quizzes in textbook.
3. Additional practice worksheets from textbook's workbook.
4. Lesson 2.4 Key Terms Crossword for additional vocabulary practice.

Materials and Resources:

Print Texts: *Principles of Engineering*

Web sites: my.pltw.org for Powerpoints, Activities, and Projects

Other Resources: fischertechnik kits, RoboPro software, assorted marbles.

DELAWARE VALLEY SCHOOL DISTRICT

UNIT: 4.1 Statistics

Big Idea # 1:

- A technological world requires that humans develop capabilities to solve technological challenges and improve products for the way we live.

Essential Questions:

- How have technological developments impacted devices, processes, and systems for the way we live?

Concepts:

- The abilities required in a technological world include diagnosing, troubleshooting, analyzing and maintaining systems.

Competencies:

- Develop the abilities to use and maintain technological products and systems.
- Improve an existing product, process, or system.
- Create a new product, process, or system.
- Safely use tools, machines, and electronic devices.
- Explain the importance of carefully assessing technological inventions and innovations.

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Curriculum Plan

Unit 4.1 Statistics **Time Range in Days: 6-8**

Standard(s): PA Academic Standards, PACCS Reading and Writing for Science and Technology

Standards Addressed: (Number Only- See Appendix for Description)
PA Academic Standards: 3.4.10.A1, 3.4.10.A2, 3.4.12.A2, 3.4.12.B2, 3.4.10.D3

PACCS: CC.3.5.9-10.A, CC.3.5.9-10.B, CC.3.5.9-10.C, CC.3.5.9-10.D, CC.3.5.9-10.J, CC.3.5.9-10.E CC.3.6.9-10.A., CC.3.6.9-10.B., CC.3.6.9-10.C., CC.3.6.9-10.E, CC.3.6.9-10.F, CC.3.6.9-10.G, CC.3.6.9-10.H, CC.3.6.9-10.I.

Anchor(s): S8.A.1.1, S8.A.1.2, S8.A.1.3, S8.A.2.1, S11.A.1.3, S11.A.2.1, S11.A.3.2, S11.A.3.3, S11.B.3.2

Overview: Engineers use statistical analysis to make decisions about engineering processes and designs.

Focus Question(s): 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 making?

Goals: It is expected that students will:

- 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.

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Objectives:

(Include DOK Levels)

1. Students shall be able to perform a basic statistical analysis of engineering data, including measures of central tendency and measures of spread of data about the mean. (DOK Level 4)
2. Students shall be able to apply Bayes' Theorem, Bernoulli Process formula, and logic principles to calculate theoretical probabilities of various engineering situations. (DOK Level 4)

Core Activities and Corresponding Instructional Methods:

Part 1:

- **Direct Instruction**
- The teacher will distribute and explain activity Career Reflection, Abstract, and Presentation to students and assign a due date.
- The teacher will present Concepts, Key Terms, and Essential Questions to provide a lesson overview.
- The teacher will present Probability.ppt.
- Students will take notes during the presentation in their journals.

Part 2:

- **Direct Instruction**
- The teacher will present Statisitics.ppt.
- Students will take notes during the presentation in their journals.

Part 3:

- **Cooperative Learning**
- The teacher will distribute and explain Activity 4.1.1 Statistical Data Exploration.
- The teacher will assign students to groups of two.
- Student groups will begin working on Activity 4.1.1 Statistical Data.

Part 4:

- **Cooperative Learning**
- Students will complete Activity 4.1.1 Statistical Data.
- The teacher will collect Activity 4.1.1 Statistical Data and evaluate using Activity 4.1.1 Statistical Data Exploration Answer Key.

Part 5:

- **Cooperative Learning**
- The teacher will distribute and explain Activity 4.1.2 Candy Statistics.
- Students will work individually to complete Activity 4.1.2 Candy Statistics.
- The teacher will collect Activity 4.1.2 Candy Statistics.

Also, assign readings from textbook on material as appropriate.

Assessments:

Diagnostic: Warmup Question Responses

Formative: Performance and responses on Activities 4.1.1 and 4.1.2, Quizzes on Textbook reading assignments

Summative: Unit Test

Extensions:

1. Textbook "Extra Mile" Challenges.
2. Additional readings and quizzes from textbook.

Correctives:

1. Additional math practice worksheets from Infinite Algebra software program.
2. Additional readings and quizzes from textbook.
3. Additional practice worksheets from textbook's workbook.
4. Lesson 4.1 Key Terms Crossword for additional vocabulary practice.

Materials and Resources:

Print Texts: *Principles of Engineering*

Web sites: my.pltw.org for Powerpoints, Activities, and Projects

Other Resources: dice, M&M chocolate candies.

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UNIT: 4.2 Kinematics

Big Idea # 1:

- A technological world requires that humans develop capabilities to solve technological challenges and improve products for the way we live.

  Essential Questions:
  - How have technological developments impacted devices, processes, and systems for the way we live?

  Concepts:
  - The abilities required in a technological world include diagnosing, troubleshooting, analyzing and maintaining systems.
  - Innovation is the process of modifying an existing product, process, or system to improve it.
  - Invention is a process of turning ideas and imagination into new products, processes, or systems.
  - Safety is a preeminent concern for all technological development and use.

  Competencies:
  - Develop the abilities to use and maintain technological products and systems.
  - Improve an existing product, process, or system.
  - Create a new product, process, or system.
  - Safely use tools, machines, and electronic devices.
  - Explain the importance of carefully assessing technological inventions and innovations.

Big Idea #2:

- Each area of technology has a set of characteristics that separates it from others; however, many areas overlap in order to meet human needs and wants.

  Essential Questions:
  - How do various areas of technology influence the economy, the environment, and society?

  Concepts:
  - Manufacturing is the process of turning raw materials into useful products.
  - Energy and power technologies are the processes of converting energy sources into useful power.

  Competencies:
  - Design and develop the ability to safely and effectively use tools and materials to manufacture products.
  - Design and develop the ability to safely and effectively use tools and materials to convert energy into useful power.

Big Idea # 3:

- Technological design is a creative process that anyone can do which may result in new inventions and innovations.

Essential Questions:

- How would you apply technological design and problem solving methods in the development of inventions and innovations?

Concepts:

- Technological design & problem solving utilizes a series of steps that take place in a well-defined sequence.
- Technological design & problem solving transforms an idea into a final product or system.
- Technological design & problem solving requires the application of hands-on abilities such as sketching, prototyping, and fabricating.
- Technological design & problem solving includes both formative and summative analysis.
- Technological design & problem solving requires the ability to clearly communicate engineered solutions.

Competencies:

- Use design and problem solving skills to solve technological challenges.
- Transform ideas into technological products and/or systems.
- Use hands-on skills to create useful products and solve technological challenges.
- Describe and demonstrate how to use the technological method to analyze technological processes and solutions.
- Clearly communicate engineered solutions in written, spoken, and graphical means.

Big Idea # 4:

- Technology is created, used and modified by humans.

Essential Questions:

- What knowledge and skills are essential for humans to make sound decisions about creating, using, and modifying technologies?

Concepts:

- Decisions about the use of products and systems can result in known and unexpected consequences.
- The use of technology involves weighing the trade-offs of the positive and negative effects.
- Science is the study of the natural world and technology is the study of the human designed world but both are inextricably connected.
- Human decision making (e.g. Human needs and wants plus cultural considerations) drives the selection and/or use of technologies.
- Creating optimal solutions under constraints are a primary component of technological problem solving (e.g., tools/machines, materials, information, people, capital, energy, and time).

Competencies:

- Explain how making informed decisions about the development and use of technology may have known and unexpected consequences.
- Describe the nature of technology and the consequences of technological activity which impact society and the world.
- Differentiate between the study of science and technology.
- Describe the complementary roles of scientific knowledge and technological application.
- Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness and the ability to visualize and think abstractly.

Big Idea # 5:

- Technological literacy is the ability to use, assess and manage technology around us.

Essential Questions:

- What is technological literacy?

Concepts:

- Technology and society mutually impact each other.
- Technological literacy is the ability to understand, use, assess, design, and produce technology (i.e. Invention & Innovation).
- Technological literacy is required for all citizens in a democratic society for shared decision-making.
- Technological literacy is necessary for a productive 21st century skilled workforce.
- Technological literacy is a lifetime endeavor.
- People select, create, and use science and technology and are limited by constraints (e.g. social and physical).

Competencies:

- Describe how technological development impacts economics, culture, and policies.
- Design and produce solutions to technological problems.
- Recognize the importance of using technological knowledge to participate competently in a democratically society.
- Develop skills for a 21st century workforce.
- Recognize technological literacy as a necessary lifetime endeavor which requires additional knowledge and information.
- Compare and contrast the natural constraints imposed on scientific and technological change.

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Curriculum Plan

Unit 4.2 Kinematics **Time Range in Days: 6-7**

Standard(s): PA Academic Standards, PACCS Reading and Writing for Science and Technology

Standards Addressed: (Number Only- See Appendix for Description)
PA Academic Standards: 3.4.10.A2, 3.4.12.B2, 3.4.10.C1, 3.4.10.C2, 3.4.12.C2, 3.4.12.C3, 3.4.10.D1, 3.4.10.D2, 3.4.10.D3, 3.4.12.D2.

PACCS: CC.3.5.9-10.A, CC.3.5.9-10.B, CC.3.5.9-10.C, CC.3.5.9-10.D, CC.3.5.9-10.J, CC.3.5.9-10.E CC.3.6.9-10.A., CC.3.6.9-10.B., CC.3.6.9-10.C., CC.3.6.9-10.E, CC.3.6.9-10.F, CC.3.6.9-10.G, CC.3.6.9-10.H, CC.3.6.9-10.I.

Anchor(s): S8.A.1.1, S8.A.1.2, S8.A.1.3, S8.A.2.1, S11.A.1.2, S11.A.1.3, S11.A.2.1, S11.A.2.2, S11.A.3.1, S11.A.3.2, S11.A.3.3, S11.B.1.1, S11.B.3.2, S11.C.3.1

Overview: Engineers use kinematics to accurately describe motion of objects.

Focus Question(s): 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?

Goals: It is expected that students will:

- Calculate distance, displacement, speed, velocity, and acceleration from data.
- Design, build, and test a vehicle that stores and releases potential energy for propulsion.
- 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

Objectives:
(Include DOK Levels)

1. Students shall be able to construct and analyze the motion of a self-propelled vehicle. (DOK Level 4)
2. Students shall be able to calculate the kinematic properties of projectiles, including initial velocity, firing angle, and range, given two of these three values. (DOK Level 2)

Core Activities and Corresponding Instructional Methods:

Part 1:

- **Direct Instruction**
- The teacher will present Concepts, Key Terms, and Essential Questions to provide a lesson overview.
- The teacher will distribute, explain, and assign Career Reflection, Abstract, and Presentation along with Career Reflection, Abstract, and Presentation Rubric. Students will complete the activity before the end of the unit. They may work on the activity during class as time allows. Additional work must be completed outside of class.
- The teacher will distribute and explain Project 4.2.1 Self-Propelled Vehicle Design.
- In teams of two or three, students will begin designing their solutions for Project 4.2.1 Self-Propelled Vehicle Design.

Parts 2 - 8:

- **Cooperative Learning**
- Students will build, design, and test their solutions for Project 4.2.1 Self-Propelled Vehicle Design.
- Students should individually answer Project 4.2.1 Self-Propelled Vehicle Design conclusion questions after completing the activity.

Part 9:

- **Direct Instruction**
- The teacher will collect the documentation for Project 4.2.1 Self-Propelled Vehicle Design.
- The teacher will deliver Projectile Motion.ppt.
- Students will take notes during the presentation in their journals.

Part 10:

- **Direct Instruction and Cooperative Learning**
- The teacher will demonstrate the functionality of the prepared ballistic design and explain the importance of initial velocity being consistent at each angle and the importance of being able to adjust the angle.
- Students will take notes in their engineering notebooks and take note of advantages, shortcomings, and ideas for improvement.
- The teacher will divide the class into teams of two or three.
- Students will use the Example Design Process document they received earlier in the year for reference during this lesson.
- Students will begin work on Project 4.2.3 Ballistic Design.

Parts 11 - 24:

- **Cooperative Learning**
- The teacher will distribute and explain the Decision Matrix Template and Decision Matrix Rubric.
- The teacher will distribute and discuss Design Modifications Chart and Citations in APA Style.
- Students will continue working on deliverables to be completed for Problem 4.2.3 Ballistic Design.
- The teacher will keep students on task and answer any questions during the process.
- The teacher will assist students to consider probability and statistics to their design. See conclusion question #3 of Project 4.2.3 Ballistic Design Answer Key.
- Students will complete Project 4.2.3 Ballistic Design.
- Students will demonstrate their solution to the class.
- The teacher will assess students using Decision Matrix Rubric and Design Problem Rubric.

Also, assign readings from textbook on material as appropriate.

Assessments:

Diagnostic: Warmup Question Responses

Formative: Quizzes on Textbook reading assignments

Summative: Project 4.2.1, Unit Test

Extensions:

1. Textbook "Extra Mile" Challenges.
2. Additional readings and quizzes from textbook.
3. Activity 4.2.2 Projectile Motion**.**

Correctives:

1. Additional independent design challenges.
2. Additional readings and quizzes in textbook.
3. Additional practice worksheets from textbook's workbook.
4. Lesson 4.2 Key Terms Crossword for additional vocabulary practice.
5. Physics practice worksheets on kinematic principles.

Materials and Resources:

Print Texts: *Principles of Engineering*

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Web sites: my.pltw.org for Powerpoints, Activities, and Projects

Other Resources: fischertechnik kits, ballistic device, table tennis balls.

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Primary Textbook(s) Used for this Course of Instruction

Name of Textbook: Principles of Engineering

Textbook ISBN #: 978-1-435-42836-2

Textbook Publisher &Year of Publication: Delmar Cengage Learning, 2012

Curriculum Textbook is utilized in (title of course): Engineering 2 (Principles of Engineering)

Appendix

Standards Addressed:

PA Academic Standards:

3.4.10.A1. Illustrate how the development of technologies is often driven by profit and an economic market.

3.4.10.A2. Interpret how systems thinking applies logic and creativity with appropriate comprises in complex real-life problems.

3.4.10.A3. Examine how technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function.

3.4.10.B1. Compare and contrast how the use of technology involves weighing the trade-offs between the positive and negative effects.

3.4.10.B2. Demonstrate how humans devise technologies to reduce the negative consequences of other technologies.

3.4.10.B3. Compare and contrast how a number of different factors, such as advertising, the strength of the economy, the goals of a company and the latest fads, contribute to shaping the design of and demand for various technologies.

3.4.10.B4. Recognize that technological development has been evolutionary, the result of a series of refinements to a basic invention.

3.4.10.C1. Apply the components of the technological design process.

3.4.10.C2. Analyze a prototype and/or create a working model to test a design concept by making actual observations and necessary adjustments.

3.4.10.C3. Illustrate the concept that not all problems are technological and not every problem can be solved using technology.

3.4.10.D1. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of a final product.

3.4.10.D2. Diagnose a malfunctioning system and use tools, materials, and knowledge to repair it.

3.4.10.D3. Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and the environment.

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3.4.12.A1. Compare and contrast the rate of technological development over time.

3.4.12.A2. Describe how management is the process of planning, organizing, and controlling work.

3.4.12.A3. Demonstrate how technological progress promotes the advancement of science, technology, engineering and mathematics (STEM).

3.4.12.B1. Analyze ethical, social, economic, and cultural considerations as related to the development, selection, and use of technologies.

3.4.12.B2. Illustrate how, with the aid of technology, various aspects of the environment can be monitored to provide information for decision making.

3.4.12.C2. Apply the concept that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

3.4.12.C3. Apply the concept that many technological problems require a multi-disciplinary approach.

3.4.12.D2. Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

3.4.10.E1: Assess how medical technologies over time have impacted prevention and rehabilitation, vaccines and pharmaceuticals, medical and surgical procedures, and genetic engineering.

3.4.10.E2: Compare and contrast how the engineering design and management of agricultural systems require knowledge of artificial ecosystems and the effects of technological development on flora and fauna.

3.4.10.E3: Compare and contrast the major forms of energy: thermal, radiant, electrical, mechanical, chemical, nuclear and others.

3.4.10.E4: Evaluate the purpose and effectiveness of information and communication systems.

3.4.10.E5: Analyze the development of transportation services and methods and their impact on society.

3.4.10.E6: Illustrate how manufacturing systems may be classified into types such as customized production, batch production, and continuous production.

3.4.10.E7: Evaluate structure design as related to function, considering such factors as style, convenience, safety, and efficiency.

3.4.12.E1: Compare and contrast the emerging technologies of telemedicine, nanotechnology, prosthetics, and biochemistry as they relate to improving human health.

3.4.12.E2: Compare and contrast the technologies of biotechnology, conservation, bio-fuels, and ecosystems as they relate to managing Earth's resources effectively.

3.4.12.E3: Compare and contrast energy and power systems as they relate to pollution, renewable and non-renewable resources, and conservation.

3.4.12.E4: Synthesize the effects of information and communication systems and subsystems as an integral part of the development of the Information Age.

3.4.12.E5: Explain how the design of intelligent and non-intelligent transportation systems depends on many processes and innovative techniques.

3.4.12.E6: Compare and contrast the importance of science, technology, engineering and math (STEM) as it pertains to the manufactured world.

3.4.12.E7: Analyze the technologies of prefabrication and new structural materials and processes as they pertain to constructing the modern world.

PACCS:

CC.3.5.9-10.A. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

CC.3.5.9-10.B. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

CC.3.5.9-10.C. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

CC.3.5.9-10.D. 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 9–10 texts and topics.

CC.3.5.9-10.J. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.

CC.3.6.9-10.A. Write arguments focused on discipline-specific content.

- Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
- Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.
- Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
- Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
- Provide a concluding statement or section that follows from or supports the argument presented.

CC.3.6.9-10.B. Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

- Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
- Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
- Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
- Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
- Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
- Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

CC.3.6.9-10.C. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CC.3.6.9-10.E. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

CC.3.6.9-10.F. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

CC.3.6.9-10.G. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

CC.3.6.9-10.H. Draw evidence from informational texts to support analysis, reflection, and research.

CC.3.6.9-10.I. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Anchors Addressed:

S8.A.1.1 - Explain, interpret, and apply scientific, environmental, or technological knowledge presented in a variety of formats (e.g., visuals, scenarios, graphs).

S8.A.1.2 - Identify and explain the impacts of applying scientific, environmental, or technological knowledge to address solutions to practical problems.

S8.A.1.3 - Identify and analyze evidence that certain variables may have caused measurable changes in natural or human-made systems.

S8.A.2.1 - Apply knowledge of scientific investigation or technological design in different contexts to make inferences to solve problems.

S8.A.2.2 - Apply appropriate instruments for a specific purpose and describe the information the instrument can provide.

S11.A.1.1 - Analyze and explain the nature of science in the search for understanding the natural world and its connection to technological systems.

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S11.A.1.2 - Identify and analyze the scientific or technological challenges of societal issues; propose possible solutions and discuss implications.

S11.A.1.3 - Describe and interpret patterns of change in natural and human-made systems.

S11.A.2.1 - Apply knowledge of scientific investigation or technological design to develop or critique aspects of the experimental or design process.

S11.A.2.2 - Evaluate appropriate technologies for a specific purpose, or describe the information the instrument can provide

S11.A.3.1 - Analyze the parts of a simple system, their roles, and their relationships to the system as a whole.

S11.A.3.2 - Compare observations of the real world to observations of a constructed model.

S11.A.3.3 - Compare and analyze repeated processes or recurring elements in patterns.

S11.B.1.1 - Explain structure and function at multiple levels of organization

S11.B.3.2 - Analyze patterns of change in natural or human-made systems over time.

S11.B.3.3 - Explain how human-made systems impact the management and distribution of natural resources.

S11.C.1.1 - Explain the relationship between the structure and properties of matter.

S11.C.2.1 - Analyze energy sources and transfer of energy, or conversion of energy.

S11.C.2.2 - Demonstrate that different ways of obtaining, transforming, and distributing energy have different environmental consequences.

S11.C.3.1 - Use the principles of motion and force to solve real-world challenges.

S11.D.1.2 - Analyze how human-made systems impact the management and distribution of natural resources.

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Checklist to Complete and Submit with Curriculum:

_____ A hard copy of the curriculum using The template entitled "Planned Instruction," available on the district website

_____ Hard copies of all supplemental resources not available electronically

_____ The primary textbook form(s)

_____ The appropriate payment form, in compliance with the maximum curriculum writing hours noted on the first page of this document

_____ A USB/Flash Drive containing a single file that will print the curriculum in its intended sequence from beginning to end and all supplemental resources that are available in electronic format.

Each principal and/or department chair has a schedule of First and Second Readers/Reviewers. Each Reader/Reviewer must sign & date below.

First Reader/Reviewer Printed Name_____

First Reader/Reviewer Signature_____ Date_____

Second Reader/Reviewer Printed Name_____

Second Reader/Reviewer Signature _____ Date_____