GEORGIA | PEACH STATE PATHWAYS

Career, Technical, & Agricultural Education

ENGINEERING & TECHNOLOGY

COURSE: Engineering Concepts (ET-EC)

UNIT: 8. Principles of Engineering in Transportation

INTRODUCTION

Annotation:

In this unit students will describe forces that act on bodies in motion, develop mathematical models to explain the variables associated with each force and use this information to solve specific problems in transportation related engineering.

Grade(s):

	9th
X	10th
X	11th
X	12th

Time:

15 hours

Author:

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Students with Disabilities:

For students with disabilities, the instructor should refer to the student's IEP to be sure that the accommodations specified are being provided. Instructors should also familiarize themselves with the provisions of Behavior Intervention Plans that may be part of a student's IEP. Frequent consultation with a student's special education instructor will be beneficial in providing appropriate differentiation.

FOCUS STANDARDS

GPS Focus Standards: Please list the standard and elements covered.

- ENGR-EC-1 – Students will describe the history and characteristics of engineering disciplines.
- ENGR-EC-2 – Students will demonstrate the engineering design process.
- ENGR-EC-3 – Students will solve problems using basic engineering tools and resources.
- ENGR-EC-5 – Students will apply engineering graphics and technical writing to communication of an engineering design.
- ENGR-STEM-1 – Students will recognize the systems, components, and processes of a technological system.
- ENGR-STEM-3 – Students will design technological problem solutions using scientific investigation, analysis and interpretation of data, innovation, invention, and fabrication while considering economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability constraints.
- ENGR-STEM-4 – Students will apply principles of science, technology, engineering, mathematics, interpersonal communication, and teamwork to the solution of technological problems.
- ENGR-STEM-5 – Students will select and demonstrate techniques, skills, tools, and understanding related to energy and power, bio-related, communication, transportation, manufacturing, and construction technologies.
- ENGR-STEM-7 – Students will develop leadership and interpersonal problem-solving skills through participation in co-curricular activities associated with the Technology Student Association.
- CTAE-FS-1 – Entrepreneurship: Learners demonstrate understanding of concepts, processes, and behaviors associated with successful entrepreneurial performance.
- CTAE-FS-2 – Academic Foundations: Learners achieve state academic standards at or above grade level.
- CTAE-FS-3 – Communications: Learners use various communication skills in expressing and interpreting information.
- CTAE-FS-4 – Problem Solving and Critical Thinking: Learners define and solve problems, and use problem-solving and improvement methods and tools.
- CTAE-FS-7 – Safety, Health and Environment: Learners employ safety, health and environmental management systems in corporations and comprehend their importance to organizational performance and regulatory compliance.
- CTAE-FS-9 – Ethics and Legal Responsibilities: Learners commit to work ethics, behavior, and legal responsibilities in the workplace.

GPS Academic Standards:

National / Local Standards / Industry / ISTE:

UNDERSTANDINGS & GOALS

Enduring Understandings: Enduring understandings are statements summarizing important ideas and have lasting value beyond the classroom. They synthesize what students should understand – not just know.

- Students will use math models to provide data for problem solving and decision making.
- Students will use sketching techniques to plan problem solving solutions.
- Students will use Computer Aided Drafting to plan problem solving solutions.
- Students will examine scientific principles essential to modes of transportation.
- Students will examine principles of fluid systems and their effect on transportation systems.

Essential Questions: Essential questions probe for deeper meaning and understanding while fostering the development of critical thinking and problem-solving skills. Example: Why is life-long learning important in the modern workplace?

- What are the forces that act on bodies in motion?
- How do scientific principles affect engineering design solutions in transportation systems?

Knowledge from this Unit: Factual information.

Skills from this Unit: Performance.

ASSESSMENT(S)

Assessment Method Type: Select one or more of the following. Please consider the type(s) of differentiated instruction you will be usin g in the classroom.

- ____ Pre-test
- X Objective assessment - multiple-choice, true- false, etc.
  - __ Quizzes/Tests
  - __ Unit test
- ____ Group project
- X Individual project
- ____ Self-assessment - May include practice quizzes, games, simulations, checklists, etc.
  - __ Self-check rubrics
  - __ Self-check during writing/planning process
  - __ Journal reflections on concepts, personal experiences and impact on one's life
  - __ Reflect on evaluations of work from teachers, business partners, and competition judges
  - __ Academic prompts
  - __ Practice quizzes/tests
- ____ Subjective assessment/Informal observations
  - __ Essay tests
  - __ Observe students working with partners
  - __ Observe students role playing
- ____ Peer-assessment
  - __ Peer editing & commentary of products/projects/presentations using rubrics
  - __ Peer editing and/or critiquing
- ____ Dialogue and Discussion
  - __ Student/teacher conferences
  - __ Partner and small group discussions
  - __ Whole group discussions
  - __ Interaction with/feedback from community members/speakers and business partners
- X Constructed Responses
  - __ Chart good reading/writing/listening/speaking habits
  - __ Application of skills to real-life situations/scenarios
- ____ Post-test

Assessment(s) Title:

Model Rockets

Assessment(s) Description/Directions:

Students are given the challenge of designing a model rocket that will travel a given distance. Use the PowerPoint, CAD, assignment sheets, and web resources to solve this engineering design challenge.

Attachments for Assessment(s): Please list.

- Thrust, Balance, and Pressure PowerPoint
- Drag PowerPoint

- Thrust and Drag Vocab
- Rocket Project Teacher Guide
- Rocket Grading Rubric
- Rocket Challenge
- Basic Criteria Analysis (Excel)
- Coefficient of Drag Excel (Excel)
- Dragster Drag Coefficient (Excel)
- Thrust and Drag Quiz
- Engineering Solution Layout (Excel)
- Model Rocket Safety Code
- Rocket Safety Test
- Flight Path (Football Field Layout)
- Altitude Estimator (Excel)
- Altitude Estimation Worksheet
- Rocket Engine Specifications
- Momentum Math Model
- Momentum Worksheet

LEARNING EXPERIENCES

Instructional planning: Include lessons, activities and other learning experiences in this section with a brief description of the activities to ensure student acquisition of the knowledge and skills addressed in the standards. Complete the sequence of instruction for each lesson/task in the unit.

Sequence of Instruction

1. Identify the Standards. Standards should be posted in the classroom for each lesson.

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2. Review Essential Questions.

- What are the forces that act on bodies in motion?
- How do scientific principles affect engineering design solutions in transportation systems?

3. Identify and review the unit vocabulary.

4. Assessment Activity.

- Go over the Thrust, Balance, & Pressure and Drag PowerPoints with students, then introduce the thrust and drag vocabulary.

- Handout Rocket Challenge. Students find three suitable nosecones for this project. Diameter of the nosecone should be larger than the diameter of a medium sized egg. The egg is the payload to be carried

by the rocket. To determine the average diameter of a medium sized egg, purchase 1 doz. eggs, measure each and get an average.

- Use Basic Criteria Analysis (Excel) to generate data to select the best solution to the nosecone selection.

- Optional – Have students draw the nosecone on AutoDesk Inventor. Weigh the nosecone and override the mass on the inventor file under iProperties.

- Open an internet browser and go to: http://my.execpc.com/~culp/Launcher/Launcher.html

- Explain each variable requested by this altitude estimator: Diameter = widest cross sectional area of rocket, Coefficient of Drag (see step 6), Delay is determined by the rocket engine. If you use C6-0, use 1 second delay. Parachute diameter only effects decent time. Thrust and Impulse is determined from the Rocket Engine Specifications. Mass of the rocket becomes the easiest variable to manipulate.

- Put a student's nosecone in a wind tunnel. Test the nosecone with a winds speed of 50 mph. Use the excel spreadsheet Coefficient of Drag to determine the students drag coefficient. This is an important variable requested on the simulator.

- Optional – Administer Thrust and Drag Quiz. Students can use the PowerPoints to answer the questions. Use excel spreadsheets Engineering Solution Layout to answer #8. Use the webpage http://my.execpc.com/~culp/Launcher/Launcher.html to answer #16 a through d. This will give students a chance to practice using this simulator to examine each variable for their individual rocket solution.

- Students try to design fuselage, engine mount, recovery unit, carriage system for the egg. Everything but fins! Weigh each part and determine the entire mass of the rocket. Be sure to include the weight of a medium sized egg and the propellant. (Option – students draw each component on AutoDesk Inventor and each is weighed and the mass is changed to reflect the real artifact under the iProperties schedule. Once the items are drawn, create an assembly. Inventor will add the mass properties and redistribute the center of gravity. The benefit of Inventor is allowing the student to examine the center of gravity of the design before actually constructing it. This will also let the student adjust the mass of the rocket up and down to achieve the desired height without changing other variables.) Hint: weight from fuselage can be adjusted easily. Determine the total weight of fuselage divided by the height to determine mass per inch. When adjusting the weight, determine how much of the fuselage can be cut to make weight.

- Students use http://my.execpc.com/~culp/Launcher/Launcher.html to adjust design according to mass and height, etc.

- Build rocket according to the planned design.

- Add fins. Three fins are recommended at 120 degrees between each. The position of the fins should be no higher on the fuselage than 1 diameter length behind the center of gravity. The fins should be, minimum, 2/3 the diameter. 1 diameter will insure that the fin is cutting into laminate flow.

- Hand out Model Rocket Safety Code and Rocket Safety Test. Have each student complete the contract and take a test on the code.

- Launch rockets on a standard football field. Secure three altimeter guns from Estes. Position one student with an altimeter gun under each goal post and position one student on the 50 yard line on one sideline. When students launch rocket have them sketch the flight path according to Flight Path (Football Field Layout). Record each reading on the flight path sheet.

- Go over Altitude Estimator with students. This Excel spreadsheet takes the data from the rocket flight path sheet and provides an estimated height using tangent trig functions.

- Use Altitude Estimation Worksheet and Altitude Estimator spreadsheet to answer questions.

- Portfolio Preparation is ongoing and submitted. Ballistic coefficient and thrusting ballistic coefficient

Attachments for Learning Experiences: Please list.

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- Momentum Math Model
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Notes & Reflections: May include notes to the teacher, pre-requisite knowledge & skills, suggestions, etc.

CULMINATING PERFORMANCE TASK (Optional)

Culminating Unit Performance Task Title:

Model Rocket

Culminating Unit Performance Task Description/Directions/Differentiated

See Rocket Project Teacher Guide and Rocket Challenge for directions. Steps can also be found under "Sequence of Instruction and Learning" below.

Attachments for Culminating Performance Task

- Rocket Project Teacher Guide
- Rocket Challenge

Rubric for Performance Task

See Rocket Grading Rubric

UNIT RESOURCES

Web Resources:

http://www.execpc.com/~culp/Launcher/Launcher.html

Attachment(s): Supplemental files not listed in assessment, learning experiences, and performance task.

Materials & Equipment:

What 21st Century Technology was used in this unit:

X	Slide Show Software	X	Graphing Software		Audio File(s)
	Interactive Whiteboard		Calculator		Graphic Organizer
	Student Response System		Desktop Publishing		Image File(s)
	Web Design Software		Blog		Video
	Animation Software		Wiki		Electronic Game or Puzzle Maker
	Email		Website		