GEORGIA | PEACH STATE PATHWAYS

Career, Technical, & Agricultural Education

ENGINEERING & TECHNOLOGY

COURSE: Invention and Innovation

UNIT 3: 3D Marble Maze

INTRODUCTION

Annotation:

In this unit, students will examine the core concepts of engineering and problem skills by constructing a three dimensional marble maze to meet specific criteria.

Grade(s):

	6th
X	7th
	8th

Time:

Fifteen 50 minute class periods

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 appropriately. 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. Many students (both with and without disabilities) who struggle with reading may benefit from the use of text reading software or other technological aids to provide access to printed materials. Many of these are available at little or no cost on the internet.

FOCUS STANDARDS

GPS Focus Standards:

ENGR-II-2 **Students will examine the core concepts of engineering and technology.**
- b) Construct a simple technological system
- c) Explain how your technological system operates

ENGR-II-3 **Students will demonstrate engineering design and problem solving skills.**
- e) Troubleshoot a product or system.

ENGR-II-6 **Students will develop leadership skills and work ethics.**
- a) Demonstrate work ethics within the classroom and lab environment.

GPS Academic Standards:

M7A1. Students will represent and evaluate quantities using algebraic expressions.
- a. Translate verbal phrases to algebraic expressions.

M7P3. Students will communicate mathematically.
- a. Organize and consolidate their mathematical thinking through communication.
- b. Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.

M7P4. Students will make connections among mathematical ideas and to other disciplines.
- c. Recognize and apply mathematics in contexts outside of mathematics.

National / Local Standards / Industry / ISTE:

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.

UNDERSTANDING & GOALS

Enduring Understandings:

- Students will understand that the engineering design process is used in the real world to solve similar problems.
- Students will understand that following the design criteria is important in achieving the goal of the final product.

- Students will evaluate the use of recyclable materials.
- Some knowledge of both mathematics and science is essential in this process.
- Students will understand that the rate at which an object travels depends on distance and time.

Essential Questions:

- Why is the engineering design process used in designing and developing a product?
- How do you keep an object moving for the longest time from point A to Point B?
- At what rate does an object travel from point A to point B?

Knowledge from this Unit:

- List the steps in the engineering design process
- Explain the relationship between mathematical variables: rate, time and distance.

Skills from this Unit:

- Students will properly use and handle simple tools such as X-acto knives, hot glue guns and measuring tapes.
- Students will apply time management skills.
- Students will construct a basic engineering project.

ASSESSMENTS

Assessment Method Type:

_____ Pre-test
_____ Objective assessment - multiple-choice, true- false, etc.
__ Quizzes/Tests
__ Unit test
_X_ Group project
_____ Individual project
_X_ Self-assessment - May include practice quizzes, games, simulations, checklists, etc.
__ Self-check rubrics
_X_ 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
_X_ Subjective assessment/Informal observations
__ Essay tests
__ Observe students working with partners
_X_ Observe students role playing
_____ Peer-assessment
__ Peer editing and commentary of products/projects/presentations using rubrics
__ Peer editing and/or critiquing
_X_ Dialogue and Discussion
__ Student/teacher conferences
_X_ Partner and small group discussions
__ Whole group discussions
__ Interaction with/feedback from community members/speakers and business partners

_____ Constructed Responses
__ Chart good reading/writing/listening/speaking habits
__ Application of skills to real-life situations/scenarios
_____ Post-test

Assessment(s) Title:

ENGR_7-3_Engineering Design Portfolio
ENGR_7-3_3D Maze

Assessment(s) Description/Directions:

Include all research information, ideas, sketches and drawings.
Each team will be given the best of three tries to find the time it takes for a marble to roll from point A to point B.

Attachments for Assessment(s):

ENGR_7-3_Engineering Design Portfolio Rubric
ENGR_7-3_3D Marble Maze Rubric

LESSON PLANS

Introduction

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

ENGR-II-2 **Students will examine the core concepts of engineering and technology.**
b) Construct a simple technological system
c) Explain how your technological system operates

ENGR-II-3 **Students will demonstrate engineering design and problem solving skills.**
e) Troubleshoot a product or system.

ENGR-II-6 **Students will develop leadership skills and work ethics.**
a) Demonstrate work ethics within the classroom and lab environment.

2. Review Essential Questions.

- Why is the engineering design process used in designing and developing a product?
- How do you keep an object moving for the longest time from point A to Point B?
- At what rate does an object travel from point A to point B?

3. Identify and review the unit vocabulary.

a. Alternative solutions
b. Model
c. Prototype
d. Design Portfolio

• LESSON 1: THE ENGINEERING DESIGN PROCESS (DAY 1)

INTRODUCE STUDENTS TO THE ENGINEERING DESIGN PROCESS

1. Show the PowerPoint **Engineering Design Process**; let students copy the eight steps.
2. Discuss each step with the students.
3. Inform them that they will create an engineering design portfolio. This portfolio contains all eight steps.
4. Students may maintain a folder to keep their information.
5. Each step should be hand written and all drawings and sketches must be in pencil.

• LESSON 2: THE 3D MARBLE MAZE PROJECT (DAY 2)

INTRODUCE STUDENTS TO THE 3D MARBLE MAZE PROJECT

1. Show PowerPoint **3D Marble Maze** slides 1 -6, discuss the problem, restrictions and constraints. Emphasize to students that the main objective is to have the marble rolling for the longest time.
2. Students will form teams of two and begin steps 1 and 2 of the Engineering design process.

• LESSON 3: DESIGN CRITERIA (DAY 3)

1. Show PowerPoint **3D Marble Maze** slides 7-8.
2. Discuss design criteria in detail, allow time for questions.
3. Discuss tools and materials that students will use. Inform them that they get one poster board, one cardboard flat and limited material. They may bring recycled products from home. Do not let students bring toy cars, blocks, tires or gears.
4. Explain to students that the cardboard flat is used as a base. Point B must end in the tray.
5. Let teams work on step 3 of the engineering design process.

• LESSON 4: BRAINSTORMING IDEAS (DAY 4 & 5)

1. Let teams begin on step 4 of the engineering design process - brainstorming ideas. Each person must think of 2 to 3 names and theme ideas for the maze. Each student must draw 2 to 3 sketches of mazes. Each maze must incorporate all design criteria.

• LESSON 5: FINALIZE DESIGN (DAY 6)

1. Teams will decide on the final design and turn it in for approval from the teacher. The theme, name and design criteria must be evident. Label clearly all design criteria. Color the maze if needed.

• LESSON 6: LOGISTICS (DAY 7)

1. Upon approval of final design, assign each team a work area and materials.
2. Discuss check out procedures for tools and materials. X-acto knives must be returned to the teacher.

   NOTE: Teacher must count X-acto knives each day before dismissing the class.

3. Demonstrate use of glue guns and safety measures. All glue guns must be returned to a designated place each day.
4. Collect marbles at the end of class each day.
5. Discuss clean up procedures. Allow 5-7 minutes of clean up time at the end of each class.
6. Allow students some time to review materials.
7. Show PowerPoint **3D Marble Maze** slides 9-13. Discuss examples by examining the themes and design criteria.

• LESSON 7: Work on Model (DAY 8, 9)

1. Review logistics, hand out X-acto knives, glue guns, glue sticks and marble to each group.
2. Constant monitoring is very important.
3. Call for clean up at the end of class

• LESSON 8: Work on Model (DAY 10)

1. Discuss speed bumps. Why do we need to incorporate them in the maze? Answer: To decrease the speed of the marble. Allow students to reason where to place speed bumps in their maze. Also discuss ideas to make speed bumps.
2. Allow students to work on the maze.

• LESSON 9: Work on Model (DAY 11)

1. Hand out **3D Marble Maze Design Rubric** to each team.
2. Discuss the rubric with students. Open for questions.

3. Allow students to use the rubric as a checklist to determine what changes and additions to make to the maze design.

• LESSON 10: Work on Model (DAY 12, 13)

1. Review logistics, hand out X-acto knives, glue guns, glue sticks and marble to each group.
2. Constant monitoring is very important.
3. Call for clean up at the end of class

• LESSON 11: Evaluate Projects (DAY 14)

1. Show students PowerPoint **3D Marble Maze**, slide 14
2. Students will view the "Rate, Distance and Time" video on Brain Pop.
3. Students will clean out unused materials from the work area
4. Teacher will move from team to team to evaluate the maze. Teams are given the best of three tries. Teacher will use the on-line stop watch at each station or may use a handheld stopwatch. Teacher will use the "3D Marble 5. Maze Evaluation Criteria" sheet to record points.

• LESSON 12: Final Calculations (DAY 15)

1. Discuss the video students watched the previous day. Inform them that they will calculate the rate at which the marble travels from point A to Point B. Explain that the rate depends on the distance from point A to point B and the time it takes for the marble to travel between the two points.
2. Let each team calculate the distance between point A and point B with the help of a tape measure. Measure in inches
3. Show students PowerPoint **3D Marble Maze**, slide 15
4. Use the table on slide 15 to convert distance from inches to feet.
5. Use the formula to calculate the rate at which the marble travels from point A to Point B.

• ATTACHMENTS FOR LESSON PLANS

1. Use the following website to watch a video on Rate, distance and time.

   http://www.brainpop.com/science/motionsforcesandtime/distancerateandtime/preview.weml
2. Stopwatch to calculate time

   http://www.online-stopwatch.com/

- **NOTES & REFLECTION:**

Establish a routine for each team to check out tools. Provide each team with a limited number of glue sticks for the glue gun. Show students the proper way to use glue guns.

Good idea to collect toilet tissue rolls and cardboard flats ahead of time. School office may have print paper box lids; they work very well as cardboard flats.

CULMINATING PERFORMANCE TASK

Culminating Unit Performance Task Title:

Students will design, build and test 3D Marble maze. The main task is to have a marble rolling from point A to point B for the longest time. Details are included in the lesson plans.

UNIT RESOURCES

Web Resources:

Use the following website to watch a video on Rate, distance and time.

http://www.brainpop.com/science/motionsforcesandtime/distancerateandtime/preview.weml

Stopwatch to calculate time

http://www.online-stopwatch.com/

Materials & Equipment:

- Poster Board, card board flat, marble
- Masking tape
- Glue gun and glue sticks, plastic mats
- Scissors and X-acto knives
- Supply of craft sticks, paper cup, construction paper, tissue rolls, straws, tooth picks and paper clips.
- You may bring in any recycled items – plastic bottles, spoons, forks etc.

Plastic toys are not allowed. Students may bring in paint and other materials for their theme.

What 21st Century Technology was used in this unit?

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