Math-in-CTE Lesson Plan

Lesson Title: Create a Mind-Challenging Game	Lesson #01

Occupational Area: Industrial Technology
CTE Concept(s): Measure accurately, use measurement tools, use problem-solving techniques
Math Concept(s): Use U.S. customary and metric measurement systems, use problem-solving techniques
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Lesson Objectives:	1. Define measurement and other key terms. 2. Use measurement systems: U.S customary and metric. 3. Use common measurement tools to calculate linear distances, diameters, and angles. 4. Measure major physical qualities of objects and structures. 5. Use problem solving techniques in the creation of products. 6. Explain how accurate measurement relates to quality control. 7. Analyze fabrication processes. 8. Evaluate fabrication processes.
Supplies Needed:	44" X 4" square of soft wood 15 golf teas or wooden pegs Tapemeasure Sand paper Paint, poly, stain finish Masking tape (12 inches) 2 Styrofoam cups String (12 inches) 1 Straw 2 Large paper clips 10 pieces Size A paper 1 Ping-pong ball 2 Rubber bands 2 Mouse traps 1 manila folder 1 12-inch ruler 1 Large envelope
Key Terms:	Area Capacity Distance Length Mass Measurement Measuring tools (direct- and indirect-read) Metric System Micrometer Precision measurement Quality Control (QC) Ruler Square Standard measurement Temperature Time U.S. Customary System Volume Weight

THE “7 ELEMENTS”	TEACHER NOTES (and answer key)
1. Introduce the CTE lesson. When you travel from your home to school, how far is the trip? How long does the journey take? Do you travel by car or bus? If so, how much fuel does that vehicle’s fuel tank hold? A book has some physical qualities. What is its weight? What size are the pages? How thick is the book? Think about how you compare with your classmates. How much do you weigh? How tall are you? How fast can you run the one-hundred-yard dash? Provide the attached **Mathematical Formulas** to all students.	These questions ask you to describe physical qualities. ***Physical qualities are*** the ***characteristics*** of an object or event that can be described. If we say a tree is tall, but have nothing to compare it to, saying the tree is tall has no meaning. The tree could be a dwarf apple tree variety or a giant redwood. If it takes a long time to do something, what is meant by a long time? Hours? Weeks? Years? Centuries? To accurately describe something to others, we must have a common reference or standard. We use measurement to describe objectively the physical qualities of an item. ***Measurement*** is the practice of comparing the qualities of an object to a standard. To describe objects using measurements, we have systems of standards for comparison.

2. Assess students' math awareness as it relates to the CTE lesson. Display the measuring devices students are going to be studying in this measurement lesson or unit. Write these key terms on the board and have the students define them 1. Area 2. Length 3. Mass 4. Metric System 5. Temperature 6. Volume 7. Weight 8. NOTE: Add more terms as needed. Evaluate students' definitions individually. Common definitions of some of the key terms essential to lesson activities are shown.	EXAMPLE: Fabrication measurement devices such as ensuring each student has a 16^{th} Scale for use in the lesson/unit 1. **Area** is a quantity expressing the extent of a 2D surface or shape in the plane. Area can be the amount of material with a given thickness needed to fashion a model of the shape, or the amount of paint needed to cover the surface with a single coat. 2. **Length**, in certain contexts, is reserved for the specific dimension of an object where length is measured. 3. **Mass** is the quantity of matter present in a object. 4. The **metric system** is an international decimalised measurement system. 5. **Temperature** is a physical property of matter that quantitatively expresses the common notions of hot and cold. 6. **Volume** is the quantity of 3-D space enclosed by a boundary. For example, the space that a substance (solid, liquid, gas, or plasma) or shape occupies or contains. 7. **Weight**, in science and engineering contexts, is the name for the force placed on an object due to gravity.

3. Work through the math example embedded in the CTE lesson.

Review the process to complete the the **"16th Scale Worksheets."** Summarize overall and individual measurement results with students as needed.

Assign the 16th Scale Worksheets attached.

FABRICATION: We live in a material world. All the products around us have been developed using material processing technology.

TASK: Make a game using the measurements shown in the game figure layout below. The game would be given to a local charity.

DEMONSTRATE: Demonstrate the safe and proper use of tools and machines (drills, saws, etc.) to construct the game.

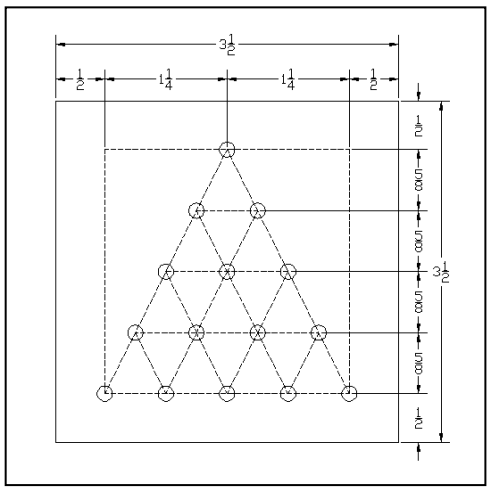
Watch the demonstration and follow the rules for the *safe and proper use of tools and machines* to make the game.

MATERIALS:

1. One piece ¾" x 3-1/2" x 3-1/2" clear pine, redwood, or western red cedar.
2. Fifteen 1/8" diameter x 1" wooden pegs or golf tees.

Collect the MATERIALS to construct the game.

GAME LAYOUT: Use the dimensions shown in the figure to layout the game.



Construct the game by following the GAME LAYOUT figure and the details in this Operation Process Chart:

Game Board	Pegs
¾ x 3-1/2 x RL Pine	1/8: Dia. X 1" Dowel
Cut to length	Cut to length
Layout Block	Sand ends
Drill 15-5/32" dia. holes	Inspect
Sand faces	Apply Stain
Sand edges and ends	Apply finish
Soften arrises (sharp edges)	Count out 15 pegs
Inspect	
Apply finish	
Package w/ directions	

Proposed GAME and SCORING DIRECTIONS: 1. Place a peg in all but one hole. 2. Select one peg and jump another adjacent peg, ending in an empty hole. 3. Remove the jumped peg. 4. Continue jumping pegs until only one remains or no other jumps are possible. ***Scoring:*** 1. Terrific: 1 peg remains = 30 points 2. Good: 2 pegs remain = 20 points 3. Fair: 3 pegs remain = 10 points 4. Try Again: 4 pegs remain = 0 points NOTE: Consider referencing **Bloom's Cognitive Taxonomy** as you and the students analyze and evaluate the game project.	Play a game or two with the game and scoring and directions provided. Then, revise the game directions and the scoring as needed. **Analysis:** Meet as a class to analyze the material processing activities. 1. Which material processing tools did you use? 2. Which measuring tools did you use? 3. How could you increase the speed of the manufacturing/fabrication process? 4. What changes in the material processing actions would you make to improve the product quality? 5. What did you learn about problem solving from this activity 6. How could what you learned about problem solving and fabrication relate to other courses you are taking? 7. How does this activity relate to other projects and information you've learned in this course so far? 8. How would you redesign the activity for the students next year? **Evaluate** the project for accuracy based on the game figure layout and the shown and operation process chart.

4. Work through *related, contextual* math-in-CTE examples.

TASK: Develop a working model of a device to move a ping pong ball 18 inches into the air and back to the origin.

Assign teams of 2 to develop a working model.

MATERIALS:

Tapemeasure	2 Mousetraps
Masking tape (12-in.)	1 Manila folder
2 Styrofoam cups	One 12-inch ruler
String (12 in.)	1 Large envelope
1 Straw	2 Rubber bands
2 Large paperclips	1 Ping-pong ball
10 pieces A-size paper	

TASK: You and your partner are to develop a working model of a device that must move a ping-pong ball 18 inches into the air and back to the origin. *[NOTE: The ball must come back to the starting point without any human help. In addition it must remain where it started at the end of the device's cycle.]* KEY: Your device must repeat the cycle accurately twice.

GATHER MATERIALS: To make the problem solving experience a bit more interesting, you are only allowed to use the materials provided by your instructor. So, if you and your partner "use up" any of the materials provided, you are not allowed to replenish those supplies. In short, be very careful how you decide to use your materials.

Create and test your device.

ANALYSIS:
1. Provide a sketch of your ideas and final solution to the problem.
2. Provide an activity summary sheet as required by your instructor including any follow-up questions.

5. Work through the *traditional math* examples.

a. Ethan adds liquid soap to the cylindrical fill cup of his parents' laundry machine. The cup is 5 centimeters deep with a radius of 5 centimeters. How many cubic centimeters of soap did he need to fill half of it?

Solutions

a.

$V = \Pi * r^2 * h * 1/2$

$V = \Pi * 5^2 * 5 * 1/2$

$V = 196.3495$

b. Logan receives a rubber ball as a birthday gift. The ball has a radius of 4 centimeters, how many cubic centimeters is in the ball?	**b.** $V = 4/3 * \Pi * r^3$ $V = 4/3 * \Pi * 4^3$ $V = 268.0826$
c. Ethan draws a circle on paper using a drafting compass. The radius of the circle was 8 centimeters. How many square centimeters are inside the circle?	**c.** $A = \Pi * r^2$ $A = \Pi * 8^2$ $A = 201.0619$
d. Natalie rides a horse down a straight slope from the top to the bottom of a hill. The hill is 8 meters tall and the slope makes a 49-degree angle to the flat ground. How many meters wide is the hill? (Assume the peak of the hill is in the middle and the slopes are the same on both sides of the peak.)	**d.** *adjacent* = 2 * *opposite* / tangent(A) *adjacent* = 2 * 8 / tangent(49) *adjacent* = 13.9086
6. Students demonstrate their understanding.	Students complete the fabrication tasks and traditional mathematics problems in the lesson plus any additional tasks assigned by the instructor. In addition, during the completion of the tasks, students: 1. Complete handouts/worksheets provided by the instructor. 2. Accurately add and subtract fractions and simplify fractions. 3. Measure accurately. 4. Use drawing scales accurately. 5. Use conversion charts (U.S. customary to metric and vice versa).

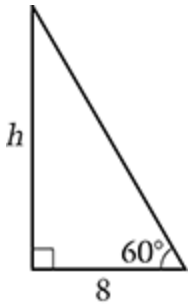
7. **Formal assessment.**	**Solutions**
Students may use the attached **Mathematical Formulas** for these formal assessment problems.	
1. Emily must measure the length of a table. She has a dollar bill that is about 6-inches long. It fits, end to end, 10 times along the length of the table. Which is the best estimate for the length of the table? A. 5 feet B. 6 feet C. 10 feet D. 12 feet	**1. A**
2. A loaded trailer truck weighs 26,643 kilograms. When the trailer truck is empty, it weighs 10,547 kilograms. About how much does the load weigh? A. 14,000 kilograms B. 16,000 kilograms C. 18,000 kilograms D. 36,000 kilograms	**2. B**
3. It takes Ms. Wylie 15 minutes to drive from her house to a store. Which is the best estimate of the distance from her house to the store? A. 5 feet B. 5 miles C. 20 feet D. 200 miles	**3. B**

4. Megan drew a rectangle that has an area of 24 square centimeters. Which of the following is likely the dimensions of her rectangle?

A. 2 centimeters (cm) by 12 cm
B. 3 cm by 9 cm
C. 4 cm by 20 cm
D. 6 cm by 6 cm
E. 12 cm by 12 cm

4. A

5.



What is the value of *h* in the figure above?

A. $4\sqrt{3}$
B. $8\sqrt{2}$
C. $8\sqrt{3}$
D. $12\sqrt{2}$
E. $12\sqrt{3}$

5. C

6. Which of the following containers has the greatest liquid capacity? (1 gal. = 4 qts. = 8 pts. = 128 oz.)

A. 64-ounces of orange juice
B. 16-pint water jug
C. 5-quart punch bowl
D. 2-quart cola bottle
E. 1-gallon milk bottle

6. B

7. Mr. Elkins plans to buy a refrigerator. He can choose from five different refrigerators whose interior dimensions, in inches, are given below. Which refrigerator has the greatest capacity (volume)? A. 42 x 34 x 30 B. 42 x 30 x 32 C. 42 x 28 x 32 D. 40 x 34 x 30 E. 40 x 30 x 28	**7. A**