8-2011

Measurement: Surviving our Multi-Dimensional World

Courtney Bryand
Trinity University

UNDERSTANDING BY DESIGN

Unit Cover Page

Unit Title: Measurement: Surviving our Multi-Dimensional World

Grade Level: 7th Grade/ 7th Grade Pre-AP/8th Grade

Subject/Topic Area(s): Mathematics: Measurement Concepts

Designed By: Courtney Bryand

Time Frame: 5 Weeks

School District: East Central ISD

School: Heritage Middle School

School Address and Phone:

8004 New Sulphur Springs Rd. ; San Antonio, TX 78263; 210-648-4546

Brief Summary of Unit

Measurement: Surviving our Multi-Dimensional World is a measurement unit with a "Survivor" theme. Many components are based on the project based learning activity *Stranded!* The unit begins and ends in a survivor scenario - students are stranded on a deserted island and must use a piece of scrap metal (an irregular figure) to design a device to catch fresh rain water so they can survive until they are rescued.

Throughout the unit, students build understanding of measurement concepts through hands on learning activities and collaboration with peers. Students learn to use measurement concepts to describe the world around them. The unit culminates with teams of students designing, building, and testing three-dimensional water catchment devices from a two dimensional figure. Students use observations and calculations to maximize the volume of their device, and tests its effectiveness through modeling activities.

The unit is designed for a 7th Grade Pre-AP class and incorporates both 7th and 8th grade measurement concepts including: area and perimeter of polygons, circles, and irregular figures; volume of prisms, cylinders, pyramids, cones and spheres; nets and surface area of prisms, cylinders, and pyramids; how perimeter, area, and volume are affected by dimensional change.

Measurement: Surviving Our Multi-Dimensional World

Stage 1 – Desired Results

Established Goals (e.g., standards)

The student is expected to:

- Estimate measurements and solve application problems involving length (including perimeter and circumference) and area of polygons and other shapes
- Connect models for volume of prisms (rectangular and triangular) and cylinders to formulas of prisms (rectangular and triangular) and cylinders
- Solve application problems involving volume of prisms (rectangular and triangular) and cylinders
- Find lateral and total surface area of prisms, pyramids, and cylinders using concrete models and nets (two dimensional models)
- Connect models of prisms, cylinders, pyramids, spheres, and cones to formulas for volume of these objects
- Estimate measurements and use formulas to solve application problems involving lateral and total surface area and volume.
- Use proportional relationships in similar two dimensional figures or similar three dimensional figures to find missing measurements ** (Based on similar figures and dilations from previous unit)
- The student describes how changes in dimensions affect linear area and volume measure. The student is expected to: Describe the resulting effects on perimeter and area and volume when dimensions of a shape are changed proportionally

Transfer

Students will independently use their learning to…

Design and build a 3-D figure with maximum possible volume out of a 2-D figure. Describe the figure in terms of estimated volume, and surface area, as well as calculated volume and surface area.

Meaning

Understandings

Students will understand that….

- We use measurement concepts to describe how we fill, cover, combine, and use the shapes that our world.
- Length (1-D), Area (2-D), and Volume (3-D) are three types of measurement that are related but are very different from one another.
- 2-D and 3-D figures can be seen as a composition of other shapes.

Essential Questions

How can we use measurement to describe a space?

How can we build and break apart figures?

Acquisition

Knowledge

Students will know…

- Perimeter, Area, Volume, and Surface Area formulas
- Measurement Vocabulary

Skills

Students will be able to…

- Calculate perimeter and area of polygons, circles, and composite shapes
- Deconstruct 3-D figures into their 2-D Nets
- Calculate Lateral and total surface area of prisms, cylinders, pyramids, and their nets
- Calculate Volume of Prisms, Cylinders, Cones, Pyramids, and Spheres
- Apply knowledge and skills to real world problem solving

Stage 2 – Evidence		
CODE (M or T)	**Evaluative Criteria** (for rubric)	
M T T T M M M M M M M M M M	- Explanation of how to know the Surface Area - Design of final device and Rationale for design -Estimated Volume of Device - Actual Volume of Device	Performance Task(s) *Students will demonstrate meaning-making and transfer by…* **Stranded! We need WATER!** After a plane crash, a group of students becomes stranded on an uncharted island. The group acquires a piece of the plane's exterior (an irregular figure), metal cutters, and duck tape, with which they will design a water catchment device. Students will use information and knowledge with regard to area, surface area, and volume to design a device that will hold the maximum amount of water to aid in their survival. They will use their understanding of what surface area is to describe the surface area of their device. They will use known formulas for volume and measurements to estimate the amount of water their device can hold. Then they will calculate the actual volume by filling their device with beans and putting those beans into a rectangular prism or other traditional 3-D solid. Activity is adapted from the *Building Math Series: Stranded.* --- Other Evidence (e.g., formative) Researching Relationships Between Measurements: - Quizzes over Perimeter (or circumference) and Area of Polygons, Circles, and Irregular Figures. - Identify at least 3 different ways to break the composite figure formed by the section of a plane's exterior into traditional shapes. Use provided information to find necessary lengths and calculate the area and perimeter of the composite figure. - Radius, Area of Base, Circumference of Base, Height, Volume, Lateral and Total Surface Area Table (for Cylinders) - Length, Width, Area of Base, Perimeter, Height, Volume, and Surface Area Table (for Rectangular Prisms) - Base of Base, Height of Base, Area of Base, Perimeter of Base, Height of Figure, Volume, Lateral and Total Surface Area Table (for Triangular Prisms - Length, Width, Area of Base, Perimeter, Height, Slant Height, Volume, and Surface Area Table (for Rectangular Pyramid) - Base of Base, Height of Base, Area of Base, Perimeter of Base, Height of Figure, Slant Height, Volume, Lateral and Total Surface Area Table (for Triangular Pyramids) - Radius, Area of Base, Circumference of Base, Height, Volume Table with given Lateral and Total Surface Area (for cones) - Radius, Area of Circle formed from Cross-Section, Volume Table with given Lateral and Total Surface Area. - C-Scope Unit Exam

Stage 3 – Learning Plan		
CODE (A, M, T)	Pre-Assessment *Chart paper will be hanging up around the room with the labels "Measurement," "Dimension," "Circumference," "Perimeter," "Area," Volume," and "Surface Area". Students will be divided into groups of 3 or 4. With their groups they will rotate through each of the stations and will record all that they know/remember about the concept, and questions that they may have that they hope to be answered throughout the unit. After groups have rotated through the 4 stations, they will have the chance to go back and look at what was added to the chart paper by other groups. The class will discuss the responses and any misconceptions will be noted. Throughout the unit, the chart paper will hang next to the word wall throughout the unit.*	
A	**Learning Activities:** Many of the activities below are from *Stranded!* Building Math; Integrating Algebra & Engineering from the Museum of Science (Wong and Brizuela) J. Weston Walch, Publisher (ISBN: 978-0-82516416-3) And C-Scope and Glencoe Mathematics Curriculum, (purchased by East Central ISD) **Day 1: Team Building and Pre-Assessment Activity:** Students will be placed in groups. Groups should be carefully designed by the teacher to take into consideration skill and ability level, as well as student personality. *Introduction to "Stranded" and team building:* - The teacher will lead discussion as students explore the "Stranded!" Scenario (page 27) and begin to chart where they are in the Pacific using prior knowledge of rates, and problem solving (page 30). - Students will complete the "Shipwreck Survivors- Team Building Activity" (page 19). - The teacher will explain that the teams will be using their knowledge of measurement to help them survive on the deserted island, and will lead the class in the *pre-assessment*. *Homework:* - Students will complete the *Defining the Problem* worksheet. **Day 2: Framing, Covering, Filling Activity** The essential question, "*How can we use measurement to describe a space?"* should be posted in the front of the classroom *Warm up:* - Students will move into their groups to discuss their responses to the prompt from the *Defining the Problem* worksheet. After 4 minutes of group discussion, groups can share observations and ideas with one another. *Framing, Covering, Filling Activity:* - The teacher will explain that in order to accomplish the task of using mathematical ideas to help them design a device for catching water, there are some measurement concepts that they need to understand. The teacher will ask the students what they think of when they hear the word perimeter and will write down all that the students say, and then the teacher will do the same with area and volume. Student responses will likely describe how to find perimeter, area and volume of familiar objects rather than what they actually are.	Progress Monitoring (e.g., formative data) - Pre-Assessment

	- In groups, students will have either a small unit of measure (small lengths of string, small note cards, lentils), a medium unit of measure (a medium length of string, medium sized note cards, and dried beans) or a large unit of measure (long lengths of string, large note cards, large marshmallows). Each group will also have 2 different sized cups, a large triangle and an irregular shape cut from butcher paper. - Two tables will be posted at the front of the room. One will list the different 2-D shapes and will have sections for students to fill in Perimeter and Area for each unit of measure. The other will list the two different sized cups and will have a place for students to fill in Volume with each unit of measure. - After the table is filled in the class will discuss relationships between the figures and the units of measure.	
A	- The teacher will ask the class, "Would it have made sense to measure the area in string?" Would it have made sense to measure the volume in note cards?" The class will discuss the difference between one-dimension, two dimensions, and three dimension and why we need different types of measure for each.	
M	*Group Discussion:* - With their groups, students will discuss the essential question and how they might use volume, area and perimeter to describe things in the classroom. They will record a reflection on the activity in their math Journals.	
M	*Homework:* - Students will look around their home and will record one thing that could be described with perimeter, one thing that could be described with area, and one thing that could be described with volume.	
	Day 3: Area and Perimeter of Parallelograms and Triangles	
M	*Warm Up: Fishing Challenge*	
A	*Class Discussion: Perimeter and Area of Triangles* - A review of how to find the area of squares and rectangles will have been discussed during the warm up. Students will be asked to use what they know about rectangles to try to discover how to find the area of a parallelogram. - There will be 4 sizes of parallelograms. Each pair of students will have only one of the parallelograms. They will measure the lengths of each side and the height of the parallelogram and calculate the perimeter. - They will then be asked to try to turn their parallelogram into a rectangle by making only one cut and reconfiguring the two pieces that result. - They will find the length and width of the resulting rectangle and fill in all their results in the Parallelogram portion of the *Discovering Area Lab Sheet.* - Partners will move around the room and "Give One and Get One" to fill in the rest of the table. Then they will return to their teams to discuss the questions that follow. - The teacher will explain the formula as it appears on the formula chart, and will relate it to the "rules" that the kids discovered.	

	- Then the teacher will ask the students what figure would be formed if we were to cut the parallelograms in half along the diagonal (a triangle). The class will write a formula for triangles based on this observations. - Students will practice finding perimeter and area of triangles and parallelograms- problems taken from Glencoe Curriculum Resources. Any items not completes in class will be homework. **Day 4: Area and Perimeter of Trapezoids**	
M	*Warm Up:* - Two parallelograms and two triangles will be given as well as work for calculating the area and perimeter. One of each will be solved correctly and one of each will be solved incorrectly. Students will look at the work and explain which work is correct/incorrect. They will find the mistakes made in the incorrect work and correct them. *Quiz* - 8 question quiz over perimeter and area of triangles and parallelograms. Problems are taken from Glencoe Curriculum.	- MiniQuiz- Area and Perimeter of Triangles
A	*Class Discussion: Trapezoids* - The steps described in the parallelogram activity will be repeated with trapezoids. Additional coaching may be needed for students to derive the formula. A review of averages may be necessary for students to see that the area is the average of the bases multiplied by the height. **Day 5:Area and Circumference of Circles**	
M	*Warm Up:* - Two trapezoids will be given as well as work for calculating the area and perimeter. One will be solved correctly and one will be solved incorrectly. Students will look at the work and explain which work is correct/incorrect. They will find the mistakes made in the incorrect work and correct them. *Quiz:* - 5 question quiz over perimeter and area of trapezoids. Problems are taken from Glencoe Curriculum. When students complete the quiz they can begin brainstorming things that they remember about circles in their math journals.	- MiniQuiz- Area and Perimeter of Trapezoids
A	*Class Discussion: Circles* - Chalk talk: *What do you know about circles?* - The class will discuss the responses to the chalk talk and vocabulary associated with circle will be reviewed including radius, diameter, pi, circumference. - The teacher will ask students to find the perimeter for circumference on the formulas chart. The students will report the formula and the teacher will write it on the front board and explain that they are going to prove why it works. - A paper circle will be drawn on a sheet of paper or transparency. The teacher will use string to show how the circumference is just over 3 diameters or 6 radii. - Next the teacher will have the students find the formula for area of circles on the formula chart. The students will report the formula, it will	

	be written on the board, and the teacher will tell them that they are going to prove that formula. - The teacher will prove the area of the circle formula using the AGATAR activity, "Area of a Circle " See Area of a Circle Instructions for more information. Students can do the activity with the teacher as time permits. - Students will practice solving area and circumference problems for circles.	
	Day 6: Mixed Practice and Applications	
M	*Warm Up:* - Two circles will be given as well as work for calculating the area and circumference. One will be solved correctly and one will be solved incorrectly. Students will look at the work and explain which work is correct/incorrect. They will find the mistakes made in the incorrect work and correct them.	
	Quiz: - 5 question quiz over circumference and area of Circles. Problems are taken from Glencoe Curriculum. - As students finish their quiz, the can read "A True Tale of Survival" from "Stranded" (page 32)	- MiniQuiz- Area and Circumference of Circles
A, M	*Practice and Application:* - Students will complete C-Scope Activity, "Perimeter, Circumference, and Area Match Up," where they will match up pictures, formulas, and application problems dealing with perimeter and area. Students can work together on the matching activity, but they will be required to find the solutions to each of the application problems individually. (taken from 7th Grade C-Scope Unit 11, Lesson 1) - The C-scope activity has a piece at the end for converting between units of measure. The teacher will use this to transition into a discussion of dimensional change (only with length and area). Students will explore this relationship further in their homework when they begin to tie the concepts of perimeter and area to the concepts of similarity from the previous unit.	- Mixed Figure Practice
A, M	*Homework: Area and Perimeter in Similar Figures*	
	Day 7: Dimensional Changes in Perimeter and Area	

A	*Warm Up:*
	- Students will use their solutions to the homework questions to answer the following questions independently in their math journals. Then they will discuss their responses with their groups and share with the rest of the class:
	  - What was the scale factor for triangles ABC and PQR?
	  - What was the scale factor when changing from one perimeter to the other?
	  - What was the scale factor when changing from one area to the other?
	  - What relationship exists?
	  - Does this relationship exist for all the problems? (If not, see if you can find another relationship that does work.)	

	Applications:	
A, M	- Students will further explore the relationships that they discovered during the warm up with actual units of measure with the 8th Grade C-Scope Lesson *Exploring Measurement* where they will build figures with tiles and double, triple, and quadruple the dimensions. Their lab sheets will be pasted in their math Journals next to their answers to the warm up questions. *Homework: C Scope Handout: My Garden*- Students will apply measurement concepts and dimensional change when working with different sized gardens	- Dimensional Change Practice and Application
	Day 8: Irregular Figures The essential question, *"How can we build and break apart figures?"* should be posted in the front of the room.	
A	*Mimio Presentation and Activity: Composite Figures* - Warm Up: Students will take a quiz assesses the skill of finding area and perimeter each of the shapes discussed so far. It is a quick check of understanding, but more importantly is made of the same shapes and measurements that the students will see in the presentation. Measurements in these shapes need to be repetitive because these shapes will be used to build composite figures. - The mimio presentation can be adapted for any interactive or smart board. If one is not available, cut outs of the shapes can be used. Introduce the Second Essential Question: *How can we build and break apart figures?* - The mimio presentation allows students to randomly select two of the shapes from the quiz and use them to build a new irregular figure. Then, they will sketch the figure and use the information that they already have about the area and perimeter (from their quiz) to fin the area and perimeter o f the new figure. Introduce the vocabulary "Irregular Figure" and "Composite Figures	- MiniQuiz-Perimeter and Area
A, M	*Practice* - Students will select 2-3 problems from 7th Grade C-Scope Lesson on Composite Figures. In this activity, students break irregular figures into traditional shapes, use a ruler to measure various lengths, and then calculate the perimeter and area. These figures will be glued into the student's math journals. - After completing 1-2 application problems together, the teacher will select three and students will select an additional two more application problems from the 8th Grade C- Scope Lesson on Composite figures to complete individually. - Homework: Students will find the perimeter and area of the piece of the planes siding that they will using to build their water catchment device.	- Composite Figure Application
	Day 9: Properties of 3-D Figures and Nets	
M	*Warm-Up*: Students will complete a journal entry reflecting on the essential questions that have been addressed: "How can we use measurement to describe a space?" and "How can we build and break apart figures?" Then they will	

	discuss their responses with their groups and will be asked, "Can the figures we have built or broken down so far be used to hold water? If not, how might we need to change the way that we build figures to make them effective in holding water?" Breaking down 3-D figures into their Nets	
A	- As a whole class, students will review properties of three dimensional figures from the previous unit. - Students will complete the C Scope Activity "Geometry Match Up Cards." In this activity, each student will have a set of cards that includes a picture of a several 3-D solids, their names, their definitions or descriptions, and their nets. Students group the cards that belong together with a partner. - Next students will create a table in their math journals to record the information.	
M	- Finally, Students will be asked to create a different net for each of the figures. Stations will be set up throughout the room with each of the paper 3-D figures the students have worked with and with each of the 2-D faces from the figures. Students can move throughout the room to manipulate the figures to find a different way to build each 3-D figure from their 2-D pieces.	
M	Homework: - Students will look at how they broke down the piece of the plane when they calculated its area and perimeter. They will find two additional ways to break it into traditional figures and will look for ways to break it down to form faces of 3-D solids.	
	Days 10-12: Prisms- Surface Area and Volume Each group will have a rectangular prism and triangular prism at their table. *Warm Up:* - Students will sketch the net of each figure on the C-Scope Surface Area hand out, a handout that provides a section for the net, a section for the name of the figure, a section to name which faces are bases and which are lateral faces, a section to identify formulas associated with the figure, and a section for calculating surface area. For the warm up the students will only be asked to sketch the net.	
A	*Surface Area* - Once the net has been drawn for each figure, the class will discuss how to find the surface area using the concept of composite figures, and will continue to fill in the C-Scope Pages. Students will measure lengths on their figures and will label those lengths on their drawings. - After practicing with lateral and total surface area using the concept of area of irregular figures, the formulas will be introduced. - Students will paste their notes in their math journals and will practice finding lateral and total surface area independently as the teacher actively monitors and assists struggling students (Worksheets will come from Glencoe curriculum resources.)	
A	*Volume:* - Students will watch a Brain-Pop Video on Volume of Prisms and use white boards to answer some of the brain pop questions.	

	- With partners, students will complete the prisms portion of the "Volume Formulas" worksheet from C-Scope. In this activity, students walk through how the formulas for volume relate to models. - Students will paste their notes in their math Journals and will begin practicing independently as their teacher monitors progress and corrects mistakes.	
M	*Volume and Surface Area Applications* - Students will complete the" research" for rectangular and triangular prisms to begin to consider relationships between surface area and volume. They will use their research to begin to discuss what types of figures will make effective water catchment devices and to begin to make connections between surface area, volume.	- Rectangular Prisms "Research" - Triangular Prisms "Research"
A, M	**Days 13-14: Cylinders- Surface Area and Volume** The cylinder pieces of the same activities listed in days 10-12 will be completed. Please note, dimensions for the 3-D solids that are needed for these activities are listed in the answer keys. The solids should be built from paper before the students complete the activities.	- Cylinders "Research"
M	**Day 15: Measurement with Prisms and Cylinders Cont.** - For the first half of class, students will participate in mixed practice using a mimio presentation in which students randomly select figure, select the 2-D faces that would be needed to build that figure, create a net, then find the volume and surface area. Objects include rectangular prisms, triangular prisms, and Cylinders.	
M	- For the second half of class, students will participate in a Four-Corners adaption of Philosophical Chairs. Each corner of the room will be labeled "Area," "Perimeter," "Volume," or "Surface Area." Students will have a reflections sheet. They will be presented with a real life scenarios or video that could apply concepts of any combination of the measurement concepts. Scenarios include rolling out fondant to the appropriate size, covering a cake, and trimming the excess from around the bottom of the cake. Painting and hanging crown molding on the walls of a room, setting u pa fish tank, including putting a decorate background along one side, covering the bottom with 2 inches of gravel, and filling the tank with water. After reflecting on each scenario, students will fill in one section of the 4-Corners Reflections Sheet. Then students will be asked to move to the section of the room that best represents their response. If they are undecided they can stay in the middle of the room. Once students have selected their corner, individual students will be invited to argue the merits of their choice. If students are swayed by the arguments they can change corners. After the class discussion students will complete the second part of the reflections page.	
	Days 15-17:Pyramids- Surface Area and Volume Each group will have a rectangular and triangular pyramid at their table. *Warm Up:* - Students will sketch the net of each figure on the C-Scope Surface Area hand out, a handout that provides a section for the net, a section for the name of the figure, a section to name which faces are bases and	

	which are lateral faces, a section to identify formulas associated with the figure, and a section for calculating surface area. For the warm up the students will only be asked to sketch the net.	
A	*Surface Area* - Once the net has been drawn for each figure, the class will discuss how to find the surface area using the concept of composite figures, and will continue to fill in the C-Scope Pages. Students will measure lengths on their figures and will label those lengths on their drawings. - After practicing with lateral and total surface area using the concept of area of irregular figures, the formulas will be introduced. - Students will paste their notes in their math journals and will practice finding lateral and total surface area independently as the teacher actively monitors and assists struggling students (Worksheets will come from Glencoe curriculum resources.)	
A	*Volume:* - The teacher will have a rectangular pyramid and rectangular prism with the same base and height. The teacher will demonstrate that they are the same base and height by holding them next to each other. The class will measure the area of the base and the height for the figures and then will calculate the volume of the rectangular prism. - The teacher will fill the pyramid with water and ask the class what the water represents (volume) - The teacher will pour the water from the pyramid into the prism and ask the class what they notice (that it doesn't fill it up all the way.) - The class will measure how full the prism is and find that it is 1/3 the original height. The class will use that information to derive the formula for the volume of a cone. - Students will practice finding volume of cones using Glencoe Curriculum Resources.	
M	*Volume and Surface Area Applications* - Students will complete the" research" for rectangular and triangular pyramids to continue exploring relationships between surface area and volume.	- Pyramids "Research"
	Day 19: Volume of Cones and Spheres	
A	- The same demonstration that was done with the prism and pyramid, will be done with a cylinder and cone. - Students will practice using formulas to discover the volume of cones and spheres. - Students will complete the "research" page for cones and spheres to make a connection to the performance task.	- Cones and Spheres "Research"
	Day 20: Applications of Volume	
	Warm Up:	
M, A	- Students will be presented with the following prompt: Did you know that all cruise ships must have enough life rafts on board for every passenger on the ship. Many of the live rafts even come equipped with sails or paddles for rowing. The US coast guard requires that each person on the life raft has 4 cubic feet of space. How many cubic inches would this be?	

	- The class will discuss how their discoveries with regard to dimensional change and scale factor applies to volume. *Preparing to build Designs*	
M, T	- The class as a whole will re-define the problem for "We Need Water!" Student will be given page 69 and the *Individual Design Sheet.* They will work independently to design their device and will prepare to present their design to the rest of their team. **Day 21-22 Performance Task**	- Individual Design and Reflections
T	- Students will move into groups and present their designs. Each Student will have 3 minutes to explain their design and a minute to answer questions that other group members may have. After each group member has presented, the team will have 10 minutes to pick and choose the pieces from each design they like, and agree upon and sketch a team design.	
T	- After the team designs have been approved, teams can begin building their device. They will have one sheet of cardboard, cut out with the appropriate dimensions, a pair of scissors, and a roll of tape.	- Group Design and Reflections
M, T	- Students will complete their measurement estimates individually, though they can consult with their group members for support. They will need to provide all work and explanations of the processes used. (note: the surface area should be the area of the irregular figure used to build the device).	- Estimated Measurements
T	- Once all members have completed their estimates, the group can test their device by pouring beans into it. Those beans will then be dumped into a rectangular prism or cylinder. The students will measure the necessary dimensions for calculating the total volume of their device. - Students will have an opportunity to showcase their devices with the rest of the class. - Students will complete individual and group evaluations (pages 104 and 106). **Day 23: Unit Exam:** Problems Taken From C-scope 7^{th} and 8^{th} Grade Measurement Unit Exams	- Actual Measurements - Measurement Unit Exam

Student Name: _____ Period: _____ Date: _____

Define the Problem

Did you know that: The average person cannot survive for more than one week without fresh water…

You and your team are stranded on an island that is surrounded by salty ocean water, but there is no fresh water on the island to drink. It has been raining almost every day since you landed on the island. A large jagged piece of plane has washed ashore, and you just happen to have supplies to cut the piece apart, and duct tape to seal it back together. Could you use this material to create a device that will catch rainwater for you and your team?

The Criteria:

- Your device must be **strong** enough to remain intact when filled to capacity.
- Your device must **be leak proof**- it cannot leak when filled, which means it must have a bottom
- Your device must have the **largest capacity possible**. At a minimum, it must hold 4,000mL of water.
- Your device must be able to **stand on its own**. You can't have it tipping over and spilling all that precious water!

Consider some of the figures we learned about during our geometry unit. Which figures that we learned about could be used to inspire your water catchment device? Which Figures would not work? Why or why not?

Fishing Challenge...

A short distance from shore, you notice an area where the fish tend to gather. You have miraculously acquired s large spool of some kind of netting that is tall enough to reach to the ocean's floor. You want to surround the area were the fish gather with the netting in order to provide food for you and your team mates. You have 50 feet of netting that you want to go around a 250 square foot area. Is this possible?

Student Name: _____ Period: _____ Date: _____

Discovering Area

PARALELOGRAMS

	Parallelogram				Rectangle		Area of Figure
	Base Lengths	Side Lengths	Height	Perimeter	Length	Width	
#1							
#2							
#3							
#4							

1. What relationships do you notice between the base lengths of the parallelograms and the lengths of the rectangles?

2. What relationship do you notice between the height of the parallelograms and the width of the rectangles?

3. What conclusions can you draw about how to find the area of parallelograms?

4. What formula can you use for the area of parallelograms?

Student Name: _____ Period: _____ Date: _____

Discovering Area

TRAPEZOIDS

	Trapezoid						**Rectangle**		Area of Figure
	Base Lengths		Side Lengths		Height	Perimeter	Length	Width	
#1									
#2									
#3									
#4									

1. What relationships do you notice between the base lengths of the trapezoid and the lengths of the rectangles?

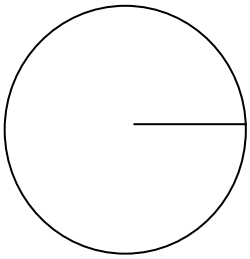
2. What relationship do you notice between the height of the trapezoid and the width of the rectangles?

3. What conclusions can you draw about how to find the area of trapezoid?

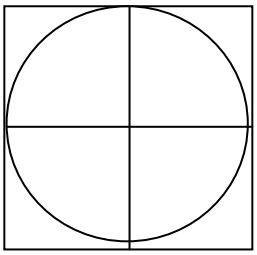
4. What formula can you use for the area of trapezoid?

Area of Circles Directions:

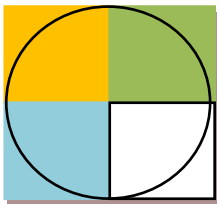
1. Start with a circle drawn on grid paper. Draw and label the radius *r*



2. Draw 4 squares with side lengths of *r* over the circle. Discuss the fact that the area og each of those squares is r^2

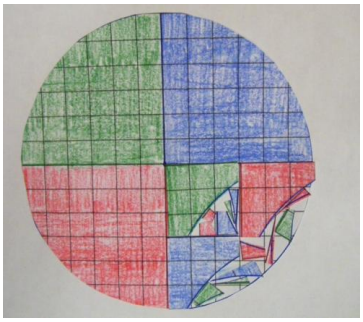


3. Shade three of the squares, each a different color. Discuss the face that the three shaded squares have an area of $3r^2$



4. Cut out the circle and the shaded pieces of the three "radius squares.

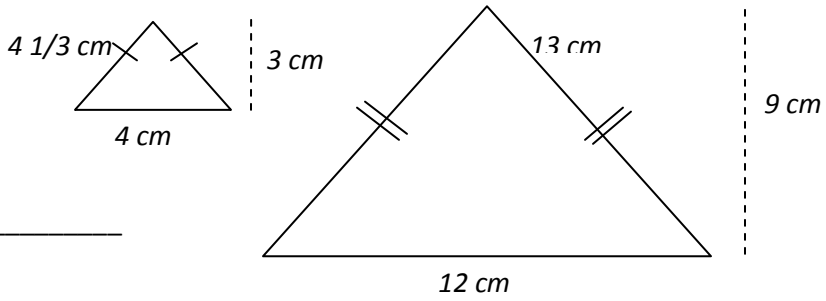
5. Use the shaded pieces of the squares to fill in the un-shaded portion of the circle to show that the area of the circle is just over $3r^2$



Student Name: _____ Period: _____ Date: _____

Perimeter and Area in Similar Figures

Triangles ABC and PQR are similar

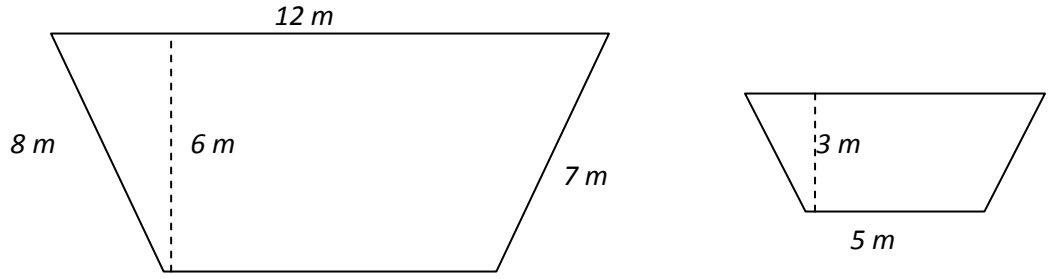


1. What is the scale factor? _____

2. What is the perimeter of:
   a. Triangle ABC _____ b. Triangle PQR _____

3. What is the area of :
   a. Triangle ABC _____ b. Triangle PQR _____

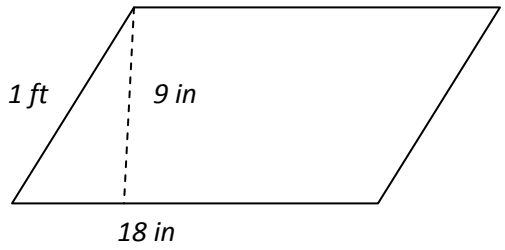
Trapezoids LMNO and WXYZ are similar. The scale factor is ½. Label any unkown lengths on the diagram. Then anwer the measurement questions.

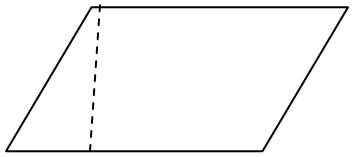


1. What is the perimeter of:
   a. Trapezoid LMNO _____ b. Trapezoid WXYZ _____

2. What is the area of :
   a. Trapezoid LMNO _____ b. Trapezoid WXYZ _____

Paralellograms EFGH and IJKL are similar. The scale factor is $^{2}/_{3}$ Label any unkown lengths on the diagram. Then anwer the measurement questions.

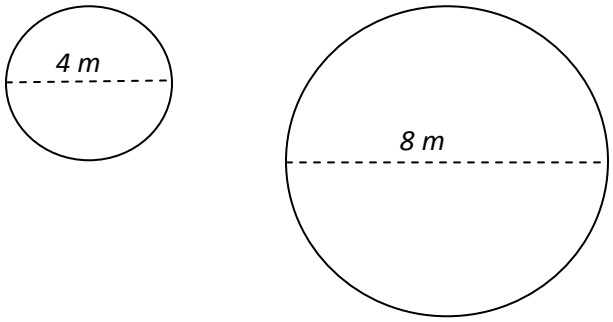




1. What is the perimeter of:
   a. Trapezoid LMNO _____ b. Trapezoid WXYZ _____

2. What is the area of :
   a. Trapezoid LMNO _____ b. Trapezoid WXYZ _____

Did you know that all circles are similar. Look at the information provided for circles W and X, then answer the questions.



1. What is the scale factor? _____

2. What is the circumference of:
   a. Circle W _____ b. Circle X _____

3. What is the area of :
   a. Circle W _____ b. Circle X _____

Student Name: _____Team Members: _____

_____

_____

RESEARCH: Rectangular Prisms

Your team has been given four rectangular prisms. Each team member will be responsible for finding the measurements for one of the rectangular prisms. Then you will share your results with the rest of your team.

1. Rectangular Prism Letter: _____
2. Name the polygon that forms the base of your 3-Dimensional Figure.

3. Use the centimeter side of your ruler to measure the :
    a. Length of the Base : _____
    b. Width of the Base : _____
    c. Height of the 3-D Solid : _____
4. Calculate the area of the base of your figure. Show your work in the space provided.

5. Calculate the Volume of your figure. Show your work in the space provided.

6. Unfold your figure. Sketch the net and calculate the lateral and total surface area of your figure using either the net or the formula. Show all your work in the space provided below.

7. Fill in the table with your data and with your group member's data :

Figure Letter	Length of Base	Width of Base	Height of Figure	Area of Base	Volume of Figure	Lateral Surface Area	Total Surface Area
A							
B							
C							
D							

8. What do all the figures have in common?

9. Which figure has the largest surface area?

10. Which figure has the smallest surface area?

11. How do the figures with the largest and smallest surface area look different? What observations can you make?

12. Do you think it is possible to have two rectangular prisms with the same surface area, but different volumes?

13. How might you use your observations from this activity to help you design a water catchment system for your group?

Student Name: _____KEY_____Team Members: _____

_____

_____

RESEARCH: Rectangular Prisms

Your team has been given four rectangular prisms. Each team member will be responsible for finding the measurements for one of the rectangular prisms. Then you will share your results with the rest of your team.

1. Rectangular Prism Letter: _____ *answers will vary*
2. Name the polygon that forms the base of your 3-Dimensional Figure.

Rectangle

3. Use the centimeter side of your ruler to measure the : *answers will vary*
   a. Length of the Base : _____
   b. Width of the Base : _____
   c. Height of the 3-D Solid : _____
4. Calculate the area of the base of your figure. Show your work in the space provided.

answers will vary

5. Calculate the Volume of your figure. Show your work in the space provided.

answers will vary

6. Unfold your figure. Sketch the net and calculate the lateral and total surface area of your figure using either the net or the formula. Show all your work in the space provided below.

answers will vary

7. Fill in the table with your data and with your group member's data :

Figure Letter	Length of Base	Width of Base	Height of Figure	Area of Base	Volume of Figure	Lateral Surface Area	Total Surface Area
A	*10 cm*	*12 cm*	*10 cm*	*120 cm^2*	*1200 cm^3*	*440 cm^2*	*680 cm^2*
B	*15 cm*	*16 cm*	*5 cm*	*240 cm^2*	*1200 cm^3*	*310 cm^2*	*790 cm^2*
C	*15 cm*	*10 cm*	*8 cm*	*150 cm^2*	*1200 cm^3*	*400 cm^2*	*700 cm^2*
D	*6 cm*	*10 cm*	*20 cm*	*60 cm^2*	*1200 cm^3*	*640 cm^2*	*760 cm^2*

8. What do all the figures have in common?

They have the same volume

9. Which figure has the largest surface area?

Figure B

10. Which figure has the smallest surface area?

Figure A

11. Do you think it is possible to have two rectangular prisms with the same surface area, but different volumes? Why or Why not?

Yes- if two figures with different surface areas can have the same volume, then two figures with the same volume should be able to have the same surface area

12. How might you use your observations from this activity to help you design a water catchment system for your group?

answers will vary

Student Name: _____Team Members: _____

_____

_____

RESEARCH: Triangular Prisms

Your team has been given four triangular prisms. Each team member will be responsible for finding the measurements for one of the triangular prisms. Then you will share your results with the rest of your team.

1. Triangular Prism Letter: _____
2. Name the polygon that forms the base of your 3-Dimensional Figure.

3. Use the centimeter side of your ruler to measure the :
    a. Base Length of the Triangle : _____
    b. Length of the other two sides : _____
    c. Height of the Triangle : _____
    d. Height of the Figure: _____
4. Calculate the area of the base of your figure. Show your work in the space provided.

5. Calculate the Volume of your figure. Show your work in the space provided.

6. Unfold your figure. Sketch the net and calculate the lateral and total surface area of your figure using either the net or the formula. Show all your work in the space provided below.

7. Fill in the table with your data and with your group member's data :

Figure Letter	Base Length of Triangle	Height of Triangle	Height of Figure	Area of Base	Volume of Figure	Lateral Surface Area	Total Surface Area
A							
B							
C							
D							

8. What is similar about these figures' measurements?

9. Which figure has the largest volume?

10. Which figure has the smallest volume?

11. How do the figures with the largest and smallest volume look different? What observations can you make?

12. How might you use your observations from this activity to help you design a water catchment system for your group?

Student Name: _____KEY_____Team Members: _____

RESEARCH: Triangular Prisms

_____

_____

Your team has been given four triangular prisms. Each team member will be responsible for finding the measurements for one of the triangular prisms. Then you will share your results with the rest of your team.

1. Triangular Prism Letter: _____ *answers will vary*
2. Name the polygon that forms the base of your 3-Dimensional Figure.

answers will vary

3. Use the centimeter side of your ruler to measure the : *answers will vary*
   a. Base Length of the Triangle : _____
   b. Length of the other two sides : _____
   c. Height of the Triangle : _____
   d. Height of the Figure: _____
4. Calculate the area of the base of your figure. Show your work in the space provided.

answers will vary

5. Calculate the Volume of your figure. Show your work in the space provided.

answers will vary

6. Unfold your figure. Sketch the net and calculate the lateral and total surface area of your figure using either the net or the formula. Show all your work in the space provided below.

answers will vary

7. Fill in the table with your data and with your group member's data :

Figure Letter	Base Length of Triangle	Height of Triangle	Height of Figure	Area of Base	Volume of Figure	Lateral Surface Area	Total Surface Area
A	*8 cm*	*7 cm*	*14 cm*	*28 cm^2*	*392 cm^3*	*336 cm^2*	*392 cm^2*
B	*10 cm*	*8.5 cm*	*10.5 cm*	*42.5 cm^2*	*446.25 cm^3*	*315 cm^2*	*400 cm^2*
C	*6 cm*	*5 cm*	*20 cm*	*15 cm^2*	*300 cm^3*	*360 cm^2*	*390 cm^2*
D	*12 cm*	*10 cm*	*8 cm*	*60 cm^2*	*480 cm^3*	*288 cm^2*	*408 cm^2*

8. What is similar about these figures' measurements?

They all have a surface area near 400 cm^2

9. Which figure has the largest volume?

Figure D

10. Which figure has the smallest volume?

Figure C

11. How do the figures with the largest and smallest volume look different? What observations can you make?

Figure D has a very large base and is fairly short. Figure C has a smaller base and is very tall

12. How might you use your observations from this activity to help you design a water catchment system for your group?

Answers will vary

Student Name: _____Team Members: _____

_____

_____

RESEARCH: Cylinders

Your team has been given four cylinders. Each team member will be responsible for finding the measurements for one of the cylinders. Then you will share your results with the rest of your team.

1. Cylinder Letter: _____
2. Name the shape that forms the base of your 3-Dimensional Figure.

3. Use the centimeter side of your ruler to measure the :
    a. Diameter : _____
    b. Radius : _____
    c. Height of the Figure : _____
4. Calculate the area of the base of your figure. Show your work in the space provided.

5. Calculate the circumference of the base of your figure. Show your work in the space provided.

6. Calculate the Volume of your figure. Show your work in the space provided.

7. Unfold your figure. Sketch the net and calculate the lateral and total surface area of your figure using either the net or the formula. Show all your work in the space provided below.

8. Fill in the table with your data and with your group member's data :

Figure Letter	Radius Length	Height of Figure	Circumference of Base	Area of Base	Volume of Figure	Lateral Surface Area	Total Surface Area
A							
B							
C							
D							

9. Describe the similarities and differences between these figures.

10. How might you use your observations from this activity to help you design a water catchment system for your group?

Student Name: _____Team Members: _____

_____

_____

RESEARCH: Cylinders

Your team has been given four cylinders. Each team member will be responsible for finding the measurements for one of the cylinders. Then you will share your results with the rest of your team.

1. Cylinder Letter: _____ *Answers will vary*
2. Name the shape that forms the base of your 3-Dimensional Figure.

Answers will vary

3. Use the centimeter side of your ruler to measure the : *Answers will vary*
   a. Diameter : _____
   b. Radius : _____
   c. Height of the Figure : _____
4. Calculate the area of the base of your figure. Show your work in the space provided.

Answers will vary

5. Calculate the circumference of the base of your figure. Show your work in the space provided.

Answers will vary

6. Calculate the Volume of your figure. Show your work in the space provided.

Answers will vary

7. Unfold your figure. Sketch the net and calculate the lateral and total surface area of your figure using either the net or the formula. Show all your work in the space provided below.

Answers will vary

8. Fill in the table with your data and with your group member's data :

Figure Letter	Radius Length	Height of Figure	Circumference of Base	Area of Base	Volume of Figure	Lateral Surface Area	Total Surface Area
A	4 cm	4 cm	25.12cm	$50.24cm^2$	$200.96cm^3$	$100.48\ cm^2$	$200.96cm^2$
B	2 cm	14 cm	12.56 cm	$12.56cm^2$	$125.84\ cm^3$	$175.84cm^2$	$200.96cm^2$
C	4 cm	9 cm	25.12	50.24	$452.16\ cm^3$	$226.08\ cm^2$	$326.56\ cm^2$
D	6 cm	4 cm	37.68	113.04	$452.16\ cm^3$	$150.72\ cm^2$	$376.8\ cm^2$

9. Describe the similarities and differences between these figures and their measurements.

Answers will vary. The goal is that students identify that the figures with the larger volumes have the larger bases rather than the tall cylinders.

10. How might you use your observations from this activity to help you design a water catchment system for your group?

Answers will vary.

Student Name: _____ Period: _____ Date: _____

Four Corners: Measurement

Senario 1:_____

_____

_____

Before You Move… Circle the choice you think best fits the scenario, then explain why you think it is the best fit.	**After Discussion…** Circle the choice you think best fits the scenario. If you changed your mind, why? If you did not change your mind, what convinced you not to?
AREA **SURFACE AREA** _____ _____ _____ _____ _____ _____ _____ **PERIMETER** **VOLUME**	**AREA** **SURFACE AREA** _____ _____ _____ _____ _____ _____ _____ **PERIMETER** **VOLUME**

Senario 2:_____

_____

_____

Before You Move… Circle the choice you think best fits the scenario, then explain why you think it is the best fit.	**After Discussion…** Circle the choice you think best fits the scenario. If you changed your mind, why? If you did not change your mind, what convinced you not to?
AREA **SURFACE AREA** _____ _____ _____ _____ _____ _____ _____ **PERIMETER** **VOLUME**	**AREA** **SURFACE AREA** _____ _____ _____ _____ _____ _____ _____ **PERIMETER** **VOLUME**

Senario 3:_____

_____

_____

Before You Move… Circle the choice you think best fits the scenario, then explain why you think it is the best fit.	**After Discussion…** Circle the choice you think best fits the scenario. If you changed your mind, why? If you did not change your mind, what convinced you not to?
AREA **SURFACE AREA** _____ _____ _____ _____ _____ _____ _____ **PERIMETER** **VOLUME**	**AREA** **SURFACE AREA** _____ _____ _____ _____ _____ _____ _____ **PERIMETER** **VOLUME**

Senario 4:_____

_____

_____

Before You Move… Circle the choice you think best fits the scenario, then explain why you think it is the best fit.	**After Discussion…** Circle the choice you think best fits the scenario. If you changed your mind, why? If you did not change your mind, what convinced you not to?
AREA **SURFACE AREA** _____ _____ _____ _____ _____ _____ _____ **PERIMETER** **VOLUME**	**AREA** **SURFACE AREA** _____ _____ _____ _____ _____ _____ _____ **PERIMETER** **VOLUME**

Student Name: _____Team Members: _____

_____

_____

RESEARCH: Pyramids

Your team has been given four pyramids. Each team member will be responsible for finding the measurements for one of the pyramids. Then you will share your results with the rest of your team.

1. Pyramid Letter: _____
2. Name the polygon that forms the base of your 3-Dimensional Figure.

3. Sketch the base of your figure, then calculate its area and perimeter.
   Perimeter: _____ Area: _____

4. Calculate the Volume of your figure. Show your work in the space provided.

5. Unfold your figure. Sketch the net and calculate the lateral and total surface area of your figure using either the net or the formula. Show all your work in the space provided below.

6. Fill in the table with your data and with your group member's data :

Figure Letter	Perimeter of the Base	Area of the base	Height of the Figure	Figure's Slant Length	Volume of Figure	Lateral Surface Area	Total Surface Area
A							
B							
C							
D							

7. Which figures were alike? Which were different?

8. How was the process for finding volume and surface are of the rectangular prisms different than finding the volume and surface area for the triangular prism?

9. Which measurements were used for both volume and surface area?

10. Would a pyramid be a good shape to meet the criteria for your water catchment device? Why or why not?

Student Name: _____Team Members: _____

_____

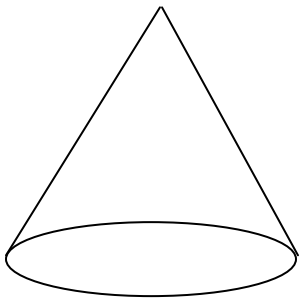
_____

RESEARCH: Cones and Spheres

Your team has been given a cone and a sphere. Use the centimeter side of your ruler to measure the lengths necessary to calculate the volume. Then calculate the volume of the three dimensional solid independently.

CONE:

1. Label the image below with the necessary measurements for calculating volume.

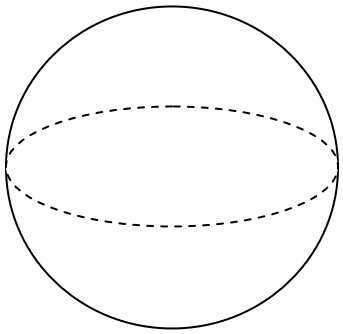


2. Calculate the volume of the cone in the space provided.

3. Suppose you had a cylinder with the same base. How tall would that cylinder need to be to have the same volume as your cone? Explain your reasoning.

SPHERE

4. Label the image below with the necessary measurements for calculating volume.



5. Calculate the volume of the sphere in the space provided.

6. Consider the constraints for your Survival Challenge. Would a cone or sphere be a good shape to use for your water catchment device? Why or why not?

Student Name: _____Team Members: _____

_____

_____

Stranded!
Individual Design

Use the research you have done to help you answer the questions below.

1. Every group has the same plane siding. If each group uses all the paper they have been given to make their water collector (without any overlapping pieces), will all the containers hold the same amount of water? Explain.

   _____
   _____
   _____
   _____
   _____

2. What observations did you make throughout the unit that you want to consider when designing your device?

   _____
   _____
   _____
   _____
   _____

3. Sketch a design in the space provided. Be as specific as possible.

Stranded! Group Design

Team Members: _____
_____
_____
_____

Sketch your design in the space provided:

Explain the reasoning behind your design. What measurement concepts helped you make decisions about your design? How do you make choices when designing your water catchment device?

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Student Name: _____Team Members: _____

Stranded! Measurements

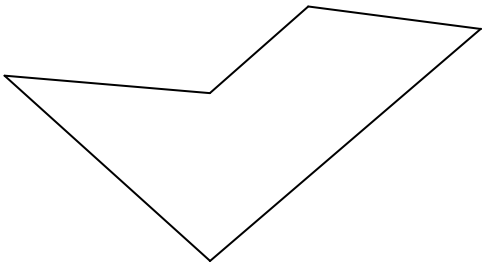
_____

_____

36.64 cm

23.71 cm

36.64 cm

Plane Siding Before:	**Water Catchment Device After:**
55.88 cm 71.12 cm 	(draw a rough sketch of your device and measure any lengths that will be necessary for completing calculations)

1. Use your understanding of volume to estimate the **volume** of your group's design. Provide all work below in a neat and organized way. Provide sketches or labels where needed. (I should be able to look at your work and know exactly what you did.)

2. Explain the processes and reasoning used when estimating the **volume** of your design. Your explanation should be clear and in complete sentences.

3. Use your understanding of surface area to estimate the **surface area** of your group's design. Provide all work below in a neat and organized way. Provide labels where needed. (I should be able to look at your work and know exactly what you did.)

4. Explain the processes and reasoning used when estimating the **surface area** of your design. Your explanation should be clear and in complete sentences.

Student Name: _____Team Members: _____

_____

_____

Test Your Design

You have estimated the volume of your design already. Now it is time to find the actual volume. Dump the beans into the 3-D Solid provided and use a ruler to find measurements needed to calculate the volume. Sketch and label a model of the figure and its fill line below. Then calculate the actual volume.

Explain the processes used calculating the actual volume of your design. Your explanation should be clear and in complete sentences.

DID YOUR DESIGN MEET ALL THE CRITERIA??

STRENGTH TEST
Was your design strong enough to stay together when filled?
___ Yes ___No

LEAKPROOF TEST
Did all the beans stay inside the design (no leaks)?
___ Yes ___No

LEAKPROOF TEST
Was your design able to stand on its own- even when full?
___ Yes ___No

CAPACITY TEST
Did your design hold 4000mL of water (4000 cm^3)?
___ Yes ___No

After testing your design, and seeing other student's designs, what would you change? What would you keep the same? Why?

Student Name: _____Team Members: _____

_____

_____

Stranded! Grading Sheet

- Self Assessment Point Values: _____
  (Based on student responses to Individual Self-Assessment Rubric from "We Need Water")
- Group Assessment Point Values: _____
  (Based on Team Evaluation Questionnaire from "We Need Water")

Recorded Grades from Checkpoints:

Activity	Area/ Perimeter	Irregular Figures	Rectangular Prism	Triangular Prism	Cylinders	Pyramids	Cones/ Spheres	Individual Design
Score								

Final Design:

	Design & Rationale for Design	Surface Area of Design	Estimated Volume of Design	Actual Volume of Design
Awesome!	Design meets all is based on observations and mathematical reasoning. The reasoning behind the design and the processes used to make decisions is clearly explained and based on Measurement concepts.	Surface Area has been correctly calculated. Explanation of process clearly demonstrates understanding of Surface Area and makes connections to area irregular figures	Volume has been correctly calculated. Explanation of process clearly demonstrates understanding of Volume and makes connections to volume of 3-D Solids.	A traditional 3-D solid has been used to accurately calculate the Volume of the design and an explanation (including visuals) describes the process used and why this method works.
Pretty Good.	Design meets all criteria and is based on observations and mathematical reasoning. An explanation of the Rationale is provided.	Surface Area has been correctly calculated. Explanation of process demonstrates understanding of surface Area.	Volume has been correctly calculated. Explanation of process demonstrates understanding of volume.	A traditional 3-D solid has been used to accurately calculate the Volume of the design and the process used has been explained in writing.
OK	Design meets all criteria, but the rationale is not based entirely on mathematical thinking. –OR– Design meets some of the criteria and reasoning is based on mathematical ideas.	Calculations are correct and demonstrate understanding of surface area. –OR– Explanation demonstrates understanding of Surface Area, though calculations may contain mistakes.	Calculations are correct and demonstrate understanding of Volume. –OR– Explanation demonstrates understanding of Volume, though calculations may contain mistakes.	A traditional 3-D solid has been used to accurately calculate the Volume of the design and all work is provided. –OR– Explanation demonstrates understanding, though calculations may contain mistakes.
Needs Work	Design does not meet the criteria. –OR– Rationale is not provided	Surface area has not been calculated correctly or no work is provided.	Volume has not been calculated correctly or no work is provided.	Volume has not been calculated correctly or no work is provided.

Final Grades: