Name: ____ Date: _____________ Period: ________

Why aren't all Ice Cream Cones "Cones"?

Opening Question

When you order an Ice Cream "cone", why is it that you can choose between one that is actually shaped like a cone and one that is more of a cylinder?

I think that all Ice Cream Cones are not scooped into "cone" shapes because ___________

____

Recall

1. What is the formula to calculate the Volume of a Cylinder?

V = ___________

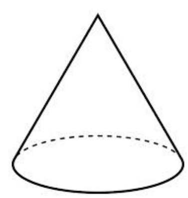
2. Which container had a greater volume (from the play-doh activity), a Cylinder with a radius of 4 cm or a cone with a radius of 4 cm? ____________________________

Predict:

1. Will the formula for the Volume of a Cylinder work for the Volume of a Cone?

a. What does *B* mean in the context of a cylinder?

B represents ___________________________



b. What is the "height" of a cone. Label the height on the cone above. Hint: When you're having your height measured, how do you stand?

I predict the formula *will / will not* hold true for cones because _________

____.

Build

Cone: From the circle you are given, cut out a sector that forms an angle with the center of at least 45° but no more than 250°. Form your cone and tape it. Measure the following and record the numbers below (use cm). Challenge: Use the Pythagorean theorem to find the slant height!

Height (Perpendicular to Base)	Diameter of Circle	Radius of Circle

Cylinder for Comparison: You will now need to build a net for a cylinder that has the same diameter/radius and height as your cone. Follow the steps, if needed to do this.

a) Trace two copies of the circle formed by your cone onto cardstock.

b) Create the rectangle that will wrap around the cylinder. What should the height be of this rectangle? ________________ How long should you make the base of the rectangle? (Consider what the rectangle will be touching when put together.) ____________________

c) Tape the cylinder together.

Test

1. Fill your cone with beans.
2. Pour those beans into the cylinder. Are the volumes equal?______________
3. Continue to fill the cone and pour the beans into the cylinder until the cylinder is full. How many "cones" full of beans did you need to fill the cylinder? ___________
4. Double check: Take the cylinder filled with beans and pour them into your cone. Each time the cone is full, empty it out and fill it again. How many cones could you fill with the one cylinder? ___

Reflect

1. So, is the volume of a cone equal to the volume of a cylinder with the same radius and same height? Why or why not?

____

2. How can you modify the formula for the volume of a cylinder to represent the volume of a cone?

Volume of a Cone Formula:

3. So why would a company make an ice cream cone that is more of a cylinder?

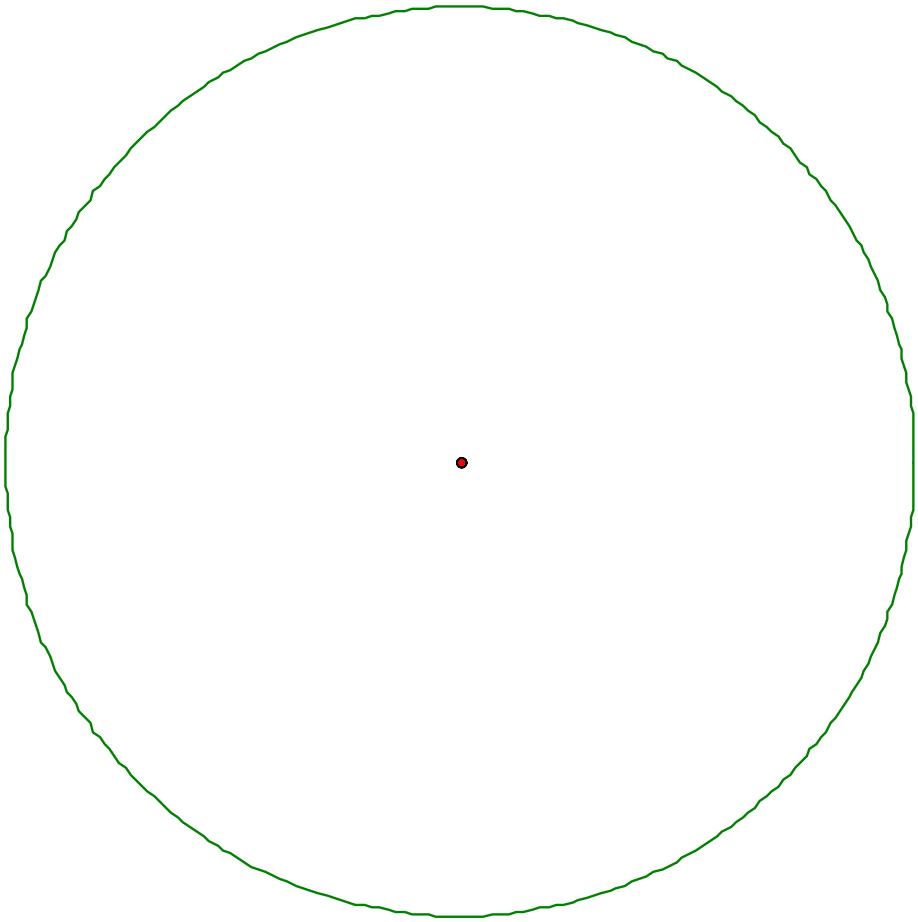
Challenge- Largest Volume

Every group was able to decide at what angle to cut their sector to create their cone. Do cuts at all angles create cones with the same volumes? Determine which angle of cut will produce the cone with the *largest* volume (starting from the same circle).

Challenge: Three Cones?

Begin with play-doh cylinder and cut it to "create" three congruent cones with the same height as the cylinder.

Cone Template



Teacher Directions

Materials:

- Beans (approx. 500 ml per group)
- Copies of the cone template on cardstock (2 per group)
- Sheet of cardstock for each group to make cylinders from (2 per group)
- Scissors (1 per group)
- Tape (2 pieces per group)
- Calculators (1 per group)
- Rulers (1 per group)
- Protractor (1 per group)
- Play-doh and plastic knife or dental floss- 1 per group for optional challenge

<u>Opening</u>

Show the pictures of the ice cream cones and pose the opening question. While students think silently, pass out the activity sheet and have them record their thoughts. Select a few students to share ideas. Next, give the students 2 minutes to complete the "Recall" questions. They should list the formula as $v = Bh$ and recall that the cylinder had greater volume.

<u>Predict</u>

Have a student read the prediction question, but before having students answer, lead a discussion about questions "a" and "b", making sure students know that "B" is the area of the circle and *h* represents the height *perpendicular* to the base (as opposed to slant height). Then let students record their prediction and take a quick thumbs up/down vote from the class.

<u>Build</u>

Show the class the "Cone Template" and explain the directions for the "build" section. Note: it they make a 60° cut (as an example) and decide to fold it in more to tape, that it completely fine! Have the materials manager from each group come get a copy of the cone template, scissors, a protractor and a piece of tape. Once a group builds their cone, give them a ruler to measure the items listed in the table. Note: there is an optional challenge to have students use Pythagorean theorem to calculate slant height.

Once a group shows you their cone and their measurements, give them 2 pieces of blank cardstock to use to construct their cylinder. Note that the directions have the students trace the circle twice and then determine how to make the rectangle. They may need help in seeing that the circumference will need to be equal to the base length of the rectangle.

<u>Test</u>

Once you verify that the cylinder a group has built has the same base and height as the cone they built, give them some beans to test out the relationship between the volume of the cone and cylinder.

Reflect

Once completed with testing, have each group hold up their cone (or create a table of class data listing the cone height and radius and then number of cones needed to fill a cylinder) and share how many cones they needed to fill.

Give each student 3-5 minutes to silently complete the reflection questions. Then allow them to share their answers with a partner and then randomly call on students to share with the class. They should conclude that the formula for the volume of a cone is $v = \frac{1}{3}Bh$ OR $v = \frac{Bh}{3}$.

Challenge - Largest Volume (optional)

Now that students know the formula for the volume of a cone, have each group calculate their volume of the cone they built and then record a class table listing cone height, radius and volume. Ask the students if all of the cones had the same volume. Give the groups a second cone template and have them experiment to determine which angle cut will generate the cone with the greatest volume.

Optional Challenge- Where are the "3" Cones?:

For groups who finish early, give them a cylinder of play-doh and a plastic knife or dental floss. Have them shape the cylinder and then cut it to reveal three equal-sized cones that have the same original height. Note: while there is a formal proof to show how the volume of 3 pyramids is equivalent to that of the rectangular prism, the 3 cones from a cylinder is more of an informal way for students to see and there is not a mathematical proof that would make sense at this developmental stage. The students can slice the original cylinder diagonally from the top to make the 3 "cones", but they will need to "roll" them to make them approximate cones.