



Introduction

This task is designed to introduce students to the ideas of calculus – in particular, finding the volume of a complex shape (a lemon). The design of the task incorporates a principle learned from research – students are more interested in new knowledge if it helps them solve a problem, and they see a need for the knowledge (Schwartz & Bransford, 1998). When students see that knowledge is important, their brains become more primed to learn it. The task helps students see the need for important principles in calculus. Students are asked to come up with their own ideas for finding the volume of a complex shape – a lemon. Instead of being told a method for finding the volume, they are invited to think deeply and creatively, using their own intuition and mathematical ideas they have already learned. Later on they can be taught concepts such as limits, which will help them solve the problem.

In order to help students solve the problem, we provide students with a range of resources that might help them investigate the volume of a lemon.

Materials

- 1 lemon per group
- As many materials as you can gather for students to use as resources to explore
 - ◊ Some ideas: a knife and cutting board, a beaker or container that is large enough to fully submerge a lemon in water, string, digital calipers and protractors (nice but not essential), play-doh, and rulers (bendable rules are best).
- 1 big whiteboard or poster paper and markers per group



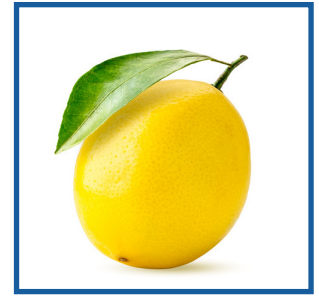
These are the items we used in our Stanford class



Agenda

Time	Task
10 min	<p>Launch</p> <ul style="list-style-type: none"> • Share with students that we are giving them a problem to solve that requires their thinking mathematically and creatively. We are not looking for any particular method, we are looking for interesting ideas and approaches. • Give each group a lemon and pose the question: <ul style="list-style-type: none"> ◊ Come up with as many ways as you can for finding the volume of your lemon. • Share the following directions: <ul style="list-style-type: none"> ◊ Make a plan with your group before sending a group member to the materials table ◊ You can only take three materials at once (to encourage building consensus first) ◊ Do not alter the lemon without group consensus ◊ Record your group's thinking on a big whiteboard • Show students a picture of the materials they have access to, so they can discuss with their group which ones they want.
30 - 45 mins	<p>Group work time</p> <ul style="list-style-type: none"> • About halfway through the work time, pass out whiteboards and remind students to document at least one of their methods, using visuals, words, symbols, and color coding. All group members should be prepared to explain that method to the class. • If you notice that a group has generated multiple methods and exhausted most of the materials, pose the following extension question: Can you write a function that models your lemon?
20 min	<p>Whiteboard talks</p> <ul style="list-style-type: none"> • If time, have all groups share their methods with the class. • Open it up for a discussion around the following questions: <ul style="list-style-type: none"> ◊ What are the constraints and affordances of different team's methods? ◊ Looking at the different methods, where do you see creativity? where do you see simplicity? Where do you see accuracy? Where do you see all three?
Later	<p>This task is a perfect way to introduce more formal methods to students, such as limits. It may be appropriate to show students new content and ask them to update their methods and approaches with the new content they have learned.</p>

This task was inspired by an activity used by Laura Evans and Carlos Cabana while at San Lorenzo High School, California.



References:

Schwartz, D., & Bransford, J. (1998). A Time for Telling. *Cognition and Instruction*, 16(4), 475-522.