PreCalculus BC: Project Six - May 19, 2017

Optimization

Optimization problems are neat to solve. In these problems, you usually write two equations with two unknowns, eliminate one of the variables, differentiate, and solve for the location of a maximum or minimum value using some variation of the first derivative test.

To start this project, solve the following cylinder optimization problem.

> A closed right circular cylinder (i.e. top and bottom included) has a surface area of 100 cubic centimeters. What should the radius and height be in order to provide the largest possible volume? Find the result if the surface area is S square centimeters.

There are several issues with this problem. Many simplifications have been made to make the problem easier to solve. These simplifications avoid many of difficulties of actually manufacturing a drum that carries some volume of liquid or other material.

In this project, your focus will be on researching what these difficulties are and how the optimal design of a real steel drum relates to the actual practice of using standard 55-gallon shipping drums. In the process of completing this project, you will be asked to solve a more complex version of the problem above and justify your solution. Please keep in mind that not all solutions to this problem will be the same.

The 55-gallon Tight Head Steel Drum

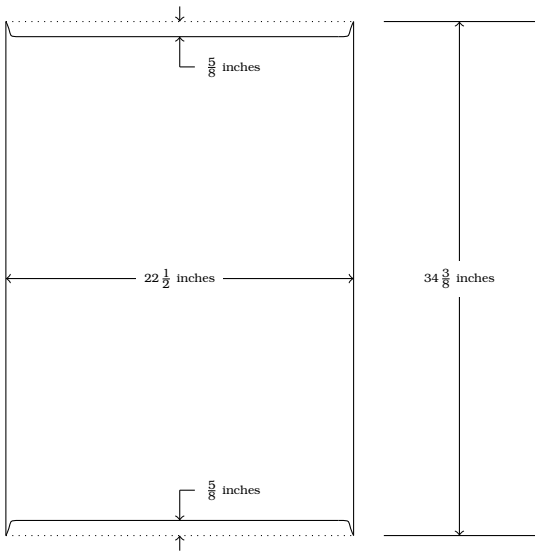
A 55-gallon Tight Head Steel Drum is used to ship a variety of liquids throughout the world. To start your project, you must become familiar with these types of containers. A good starting point (although not a required one) is the Wikipedia page (`http://goo.gl/ORT1yd`). Remember that case matters when you type this link into your browser.

By the way, it is quite common for homeowners to use some variation of this type of drum in making their own rain collection system. These drums can also be used to make your own BBQ pit!

Construction Details

The 55-gallon Tight Head Steel Drum is constructed by attaching 18 gauge steel disks to the top and bottom of a cylinder created by rolling up a 20 gauge steel sheet. For an explanation of the word gauge, try (`http://goo.gl/GX4IDN`)

The vertical seam on the cylinder is welded together and the top and bottom are attached by a pressing/sealing machine. The pressing/sealing process requires approximately $\frac{13}{16}$ inches from the cylinder and $\frac{3}{4}$ inches from the disk to be curled together and hence these inches are lost in the final dimensions. In addition, the top and bottom are set down $\frac{5}{8}$ inches into the cylinder. For clarification, the specification diagram from the American National Standards Institute (ANSI) document is given below.



Cost

Steel can be purchased in coils (rolls) on any specified width. If you'd like to see an example of how this steel is purchased, try (`http://goo.gl/dhCxlq`).

Since the price of steel does change over time, for this project let's make the following cost assumptions:

1. 18 gage steel is 45 cents per square foot.
2. 20 gage steel is 34 cents per square foot.
3. welding and pressing/sealing cost is 10 cents per foot.
4. cutting steel costs 2 cents per foot.

The Question

Is the ANSI specified drum the most efficient use of material in order to obtain the required minimum volume capacity of a 55 gallon drum? Fully justify your answer.

Your Report

Your tex file name should follow the same naming convention we have been using all year: `lastname_optimization.tex`

In your report, I will be looking specifically at whether you have answered the question about whether the ANSI drum is the most efficient use of material. You should use similar guidelines from previous reports to fully-justify your answer. In addition, it might prove interesting to research the history of 55-gallon drums and include that information in your report.