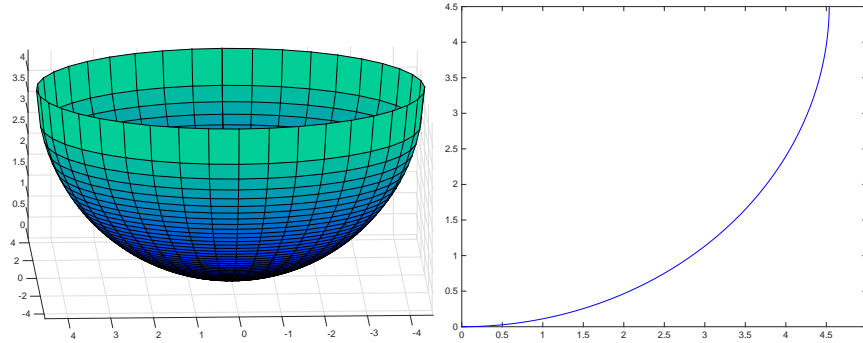# Math 315: Eco Bottle Design

Last week, we determined that the minimal the amount of material needed to create a bottle that holds 6.5 ounces of liquid would be the bottom half of a sphere (see pictures below). Use this information and the MATLAB program you wrote last week to calculate Surface Area, to redesign your bottle so that it uses less plastic.

To redesign you bottle, please follow the following steps.

Step 1: Make sure your bottle has an open top and close bottom. Plot your bottle. Make sure the contour of your bottle starts at $(0,0)$ but does *not* finish touching the y-axis.

Step 2: Make sure your bottle holds 6.5 oz (or 192.228 mL). If your bottle does not have this volume, please run the following code:

```
[xvals,yvals,V] = ParSpline(x,y,2000);
s_vol = abs(V)/192.228;
y = 1/(s_vol)^(1/3)*y;
x = 1/(s_vol)^(1/3)*x;
```

Step 3: Calculate the surface area of your original bottle, using

```
[xvals, yvals, A] = SurfaceArea(x,y,2000)
```

Write the value of `A` here: _____

Step 4: Resign your bottle to use less plastic. Incorporate the minimal surface into your design. Keep in mind, you will want to keep key features of your original design but use less plastic. Some values along the minimal contour are given below.

```
x_min = ...
 [0    0.7822    1.5409    2.2535    2.8986    3.4568    3.9115    4.2490    4.4592    4.5358];
y_min = ...
 [ 0    0.0679    0.2697    0.5994    1.0469    1.5990    2.2390    2.9479    3.7044    4.4858];
```

Write the NEW value of `A` here: _____. Be sure to check that the volume is still approximately 192.2.

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What to Turn In - How and When.

Redesign: Due: December 2 by 5:00 PM

Send an email to Prof. Ettinger at betting 'at' emory.edu with:

   Subject: Math 315 Bottle - Student Name1, Student Name 2
   Body:

     (1) Bottle Design Details
       Original Verticies
       `x = [ Fill in your original vertices ];`
       `y = [ Fill in your original vertices ];`

       Vertices Scaled for a volume of about 192.2 mL/6.5 oz.
       `x_s = [ Fill in your scaled vertices ];`
       `y_s = [ Fill in your scaled vertices ];`

       Eco Redesign Vertices
       `x_eco = [ Fill in your redesigned vertices ];`
       `y_eco = [ Fill in your redesigned vertices ];`

       By redesigning my bottle I reduced the surface area from [FILL IN SCALED ORIGINAL AREA] cm^2 to [FILL IN NEW REDESIGNED AREA] cm^2.

     (2) Display Card Write-Up
       Prepare a short statement (100 words) to be displayed with your bottles that describes the inspiration for your designs as well as the key features you decided to keep in your redesign. Be sure to include the amount of materials needed for the original design as well as the amount you saved in the redesign.

Reflection Paper: Due: December 13 by 5:00 PM

Write a reflection on the project. Some questions you may address are: What where some of the challenges of the bottle design project? What did you learn about the roles mathematics and scientific computing play in design? What is the feasibility of optimal design and how does it limit (or expand) ones creativity? Are 3D computer models sufficient or is there an added benefit to generating a tangible version of your bottle via the 3D printer?

Papers should be 2 to 3 pages, single spaced with 12 point font and 1.25" margins. Every student must turn in their own paper, even if they worked in a pair. This assignment will open on December 2 and will be turned in on Gradescope.