BC Calculus   Name: _____
2012/13 – After the AP exam

Water goblet design project:

You are to design a water goblet that meets the following specifications:
1. The goblet must be a solid of revolution.
2. The goblet must hold 150 ± 10 cm^3 of water.
3. The goblet must require no more than 150 cm^3 of glass to manufacture.
4. The glass thickness may not be less than 0.25 cm anywhere.
5. There should be no sharp edges anywhere.
6. The goblet should not be tipped over easily. Therefore, the ratio of the height, h, of the goblet to the base radius, r, must be such that $h / r \le 6$.

Note: 1 unit = 1 cm. No tricks!

Any goblet that meets all six requirements and for which all calculations are done correctly will be entered into a competition in which the goblets will be judged on aesthetic value only. The winning entry will earn a wonderful prize.

The project will be worth **100 points**. You must submit to me for grading:

A 14-in. by 22-in. poster showing, at a minimum,
1. a cross-sectional, **_reflected_** view, **_without axes_**, of the goblet obtained using Winplot (10 points),
2. a **_second_** cross-sectional view, either on the front of the poster (if typed) or on the back (if hand-labeled), on which the functions and points of intersection are clearly labeled. This view does not need to be reflected (10 points).
3. a 3-D <u>color</u> illustration of the goblet obtained using Winplot that is tilted to show the inside of the goblet (10 points),
4. the functions (typed) used to generate the goblet along with the points of intersection of the functions (10 points).

The poster will also be graded on neatness (5 points) and creativity (5 points). The creativity score will include consideration of the complexity of the design and the roundedness of the edges. Creativity points will be lost if an excessive number of functions are obtained by regression.

In addition, you must show me the equations used to calculate
1. the capacity of the goblet (15 points)*,
2. the volume of glass used in manufacturing the goblet (25 points)*,
3. the ratio of the height of the goblet to the bottom radius (2 points),
4. the thickness of the goblet at the thinnest point (3 points).

* For the calculations of the capacity and the glass volume, show the values of the integrals that you add to obtain the totals.

These equations may be hand-written or typed; however, neatness counts (5 points)!!! Any hand-written work should be placed on the **back** of the poster. **You should provide enough detail that I could EASILY reproduce your goblet and calculations.** Yes, I really do check your calculations,

and the easier it is for me to check your calculations the better my frame of mind when assigning the grade. Extra credit will be awarded for ***professionally*** laminating your poster (5 points).

And, finally, you must submit to me the final Winplot file that you use to create the goblet (kcrabb@gvsd.org).

If you choose, you may download the freeware program Winplot to your own computer:

1. Go to **http://math.exeter.edu/rparris/winplot.html**
2. Click on **Winplot** in the top line**.**
3. Click on the arrow next to **Save** and choose **Save as**. Choose or create a folder in which to save the zipped file (wp32z.exe).
4. **Run** the program (wp32z.exe) to **unzip** the file. The **Winplot** program file will be saved in the same folder.
5. Run **Winplot**.

There are very few built-in instructions in Winplot. However, I found a helpful tutorial; you want to look at the first section, Graphs in 2D. The address is

http://faculty.matcmadison.edu/alehnen/winptut/winpltut.htm

Miscellaneous additional _requirements_ and advice:

1. You can, and should, do all of the work for this project in Winplot. The program is much faster than the TI-89 both in graphing and in calculating integrals.
2. When using exponential functions, use the **exp()** function. DO NOT USE e^(). The program reads the "e" as a variable, and this can lead to problems**.**
2. Avoid vertical line segments; they do not show up in the 3-D view of the goblet in Winplot.
3. Do not save points of intersection as parameters x, y, or $z.$
3. In the cross-sectional view, scale the x and y axes similarly to give an undistorted view.
5. You must find and work with precise points of intersection of the functions. You can save the points of intersection in Winplot just as you can on the TI-89.
6. Keep a sketch of the goblet on which you label the functions and points of intersection; e.g., label which curve is $y1(x)$, which point of intersection you've stored as A, etc.
7. After creating a rough view of the goblet, determine whether the capacity is correct and make the necessary changes; then worry about the volume of glass used. I used a window that was about 15 by 7.
8. Be sure to close off the bottom of the goblet.
9. For summing up long strings of integrals, you may round the individual integrals (at least 3 decimal places) and then add them up without storing the exact values. **Show me the individual values of these integrals.**
10. Winplot is free and does amazing things; however, it is not the most robust. **SAVE YOUR WORK EARLY AND OFTEN; REALLY!**
11. Keep in mind that the project is iterative. It may take several tries to obtain a goblet that meets all of the requirements. **BE PATIENT!**

End-of-year schedule:

May 9-23:   Work on projects.
Friday, May 24:   **Goblet projects are due by the end of homeroom.**
                   Note: This is the day of the awards assembly and senior prom!

Thursday, May 30 - Friday, May 31: **Senior "creative" project presentations.**
Monday, June 3:   Senior final.
Wednesday, June 5 - Friday, June 7: **Junior "creative" project presentations.**
Tuesday, June 11:   Underclass final.