Calculus II Project 1
Designing a Dome Tent

Due: Monday 11th February in class. You must hand in a printout of your write-up.

Imagine making a tent in the shape of a spherical cap (a sphere with the lower portion sliced away by a plane; something like the picture below).

![Diagram of a spherical cap](image)

We want the volume to be 2.2m$^3$. Draw a picture, identifying all the appropriate variables. Here are a couple of formulæ that you may find useful. If the cross-section of your tent looks like the grey area in the diagram below,

![Diagram of a cross-section](image)

then the volume is

$$V = \pi \left( \frac{2}{3} R^3 - R^2 h + \frac{1}{3} h^3 \right),$$
and the surface area of the dome part of the tent is
\[ A = 2\pi R(R - h) \, . \]
Here \( R \) is the radius of the original sphere, and \( R - h \) is the height of your tent.

The floor of the tent is cheaper material than the rest, in fact the cost of the material making up the dome of the tent is 1.4 times the cost per square metre of the material for the floor.

1. What should the dimensions of the tent be so that the cost of the material used is a minimum?
2. What is the total area of the material used?

Now change the problem so that the floor of the tent is of a more expensive material than the rest. This time the material of the floor is 1.4 times as expensive per square metre as the material for the rest of the dome.

3. What should the dimensions of the tent be so that the cost of the material used is a minimum?
4. What is the total area of the material used?
5. How practical would these two tents be?

**Project Guidelines**

1. **Notes on Grading**
   
   The mathematical content of this problem is relatively straightforward. The purpose is for you to experience writing about mathematics. Thus, out of the 25 points for this project, only 10 will be awarded for getting the answer correct. The rest will assess your write-up and presentation.

2. **Group Work**

   You should plan your first group meeting as soon as possible, but before that you should have read the project carefully and given it some thought. At your first meeting you should plan a method of attack and you may wish to divide the labour among the group members. Different members of the group may perform different tasks, but all are expected to understand the solution totally. Regular group meetings to discuss the project are crucial. Your group should have between two and four members.

   You may seek assistance from me or from Prashant. If you cannot attend our office hours, then you may make an appointment to see us at other times. You would be wise to consult with one of us even if you think things are going well; this will help you avoid dead-ends.

   The paper you turn in should have a mix of equations, formulæ, graphs and prose to support your conclusions. The prose should be written in complete sentences that convey to the reader an explanation of what you have done. Each group will turn in one paper, signed by every member of the group.
The projects must be accompanied by an evaluation of the group participation of each member of the group, from each member of the group. I will use this information to adjust the individual scores on the projects. You will find suggested evaluation criteria below.

The cardinal rule of group work is that it is your responsibility to see that every member of your group understands every part of the project.

3. Group Evaluations

2.1 Describe how your group operated.

2.2 Evaluate your group members individually. You may use the following criteria, ignore them, or augment them. But please include explanatory comments and justifications in any case.
   (i) Did he/she demonstrate willingness to work with other group members regarding scheduling and work assignments?
   (ii) Conflict management. Did he/she recognize conflict and initiate constructive efforts to resolve it?
   (iii) Preparation for group meetings. Was his/her work on time? Was there advance notice of his/her not showing up on time or being late? Did he/she participate actively?
   (iv) Consideration. Did he/she treat the members of the group with respect and consideration for their situations?
   (v) Group citizenship. Was he/she willing to contribute without coercion, to attend meetings and make deadlines, to communicate problems with the project or with other members, to deliver and receive criticism in a constructive manner?
   (vi) Doing his/her part. Did he/she do what the team agreed he/she should do? Did he/she do what he agreed to do?
   (vii) What changes, if any, would you like to see next quarter regarding the groups and projects?