Math 132-01 Project A

first draft due September 17, final version due September 26

For this project, you will be working in groups of 3 or 4 and writing up your solutions in groups of 2 or 3. Before you begin, choose one person to be the recorder and one to be the prompter. The duty of the **recorder** is to write down the ideas that you try and the insights and solutions that you discover. The job of the **prompter** is to make sure that everyone gets a chance to contribute and that everyone understands what has been done. Never hesitate to say if you don't quite understand what has been said or done. It is when one person explains what they think they understand to someone else that uncertainties or weaknesses can be found.

The answers to this project are to be submitted as a project report. It should be possible to find answers to all of the questions by reading your report, but do **not** lay out the report in a question-answer format. It should be written as a report to someone who asked you to figure out how to calculate the moments of the four cutouts. It should be written so that a student in another calculus class could pick it up and understand what you have done and why you have done it. You should not assume that the person who reads your report knows what the questions are. Start with an introduction that explains the problem and lets the reader know what you have found. Explain how you got to this solution, how confident you are, and why you are or are not confident of this answer. Write clearly using complete sentences and well-structured paragraphs. There should be a brief conclusion summarizing what you accomplished in this report.

The first draft will not be graded. I will comment on it and return it to you for improvements. I am looking not just for correct answers, but also for clear explanations.

Greater Boston (the city of Boston and its near suburbs) can be approximated by a semicircle of radius 8 miles with its center on the coast. Moving away from the center along a radius, the population density is constant for the first mile. Beyond that, the density starts to decrease according to the data given in the table where $\rho(r)$ is the population density at a distance r miles from the center.

r (miles)	0	1	2	3	4	5	6	7	8
$\rho(r)$ (thousand people/mi^2)	75	75	67.5	60	52.5	45	37.5	30	22.5

1. Using this data, estimate the total population of Greater Boston living within the 8-mile limit.

2. Looking at the data, do you think your answer to question 1 is an overestimate or an underestimate? Why?

3. What do you expect the population densities to be at 1.5, 2.5, 3.5, ..., 7.5 miles? Use this data and the population densities at 0, 1, ..., 8 miles to estimate the total population of Greater Boston living within the 8-mile limit.

4. Find a reasonable formula for $\rho(r)$. Write the summation that expresses the estimate of the total population when we measure the population density at every tenth of a mile. Evaluate this summation.

5. Write the summation that expresses the estimate of the total population when we measure the population density at every Δr miles.

6. What integral does this summation become when we take the limit as Δr approaches 0? Evaluate this integral and check your result by comparing it with the numerical approximations.

7. Were the numerical approximations too high or too low? Explain why they over-estimated or under-estimated the true value.

Write your report so that it can be read by a calculus student from the other section who has not seen these questions. Do not refer to the questions by number. Your report should have an introduction that explains the problem that you will solve. It should include an explanation of what you did and why you did it and what you discovered. Include the errors you made and how you knew that they were wrong and how you corrected them. Conclude with a summary of what you learned from this project.