Math 450
Programming Assignment 3
Due: Friday November 30th

1. Suppose that you have been contracted by a local Police Department to write a program that analyzes data gathered by a photo radar system in order to accurately compute the maximum speed of a vehicle based on the data collected. The photo radar system records the initial position of the vehicle, and then computes the total (cumulative) distance traveled from the initial location 0.1 seconds later, 0.2 seconds later, 0.3 seconds later, 0.4 seconds later, and 0.5 seconds later. These distances are recorded in feet.

   (a) Write a program the takes as input values representing the total distance traveled by a vehicle during the time increments described above and outputs approximations of the instantaneous velocity of the vehicle at the times $t = 0$, $t = 0.1$, $t = 0.2$, $t = 0.3$, $t = 0.4$, and $t = 0.5$. Make your program as accurate as possible. For convenience, you should make the units of your output miles per hour. [Note that you can get an extra data point by taking the total distance traveled at time $t = 0$ to be zero].

   (b) Use your program to determine whether or not the following vehicle who was recorded traveling on a highway with speed limit 60 miles per hour broke the speed limit.

time (in seconds)	total distance (in feet)
0	0
0.1	8.813037037
0.2	17.62607407
0.3	26.4
0.4	35.09570370
0.5	43.67407407

2. Write programs that implements each of the following numerical integration methods. Your algorithm should take as input a function $f(x)$, an interval $[a, b]$, and n, the number of subdivisions of the interval $[a, b]$ that will be used.

   (a) Composite Trapezoid Rule.

   (b) Composite Simpson's Rule.

   (c) Romberg Integration [this algorithm will need an additional input k which will represent the final level computed, $R_{k,k}$].

   (d) Adaptive Quadrature [this algorithm will need an additional input ε, the error tolerance desired].

3. Use each of your algorithms to approximate $\displaystyle\int_0^1 \frac{4}{1+x^2}\,dx$ to within $\epsilon = 10^{-6}$. Be sure to explain how you know the desired tolerance has been reached.