PHYS 305 – Homework #1 **Due: Sept. 2, 2024**

1. Write code that takes a temperature in Fahrenheit that is input by the user from the keyboard and converts it to Celsius. The output should be print to the screen.
2. Write a function that computes the work done by an ideal gas when it expands from one volume to another. The volumes and the number of steps should be arguments to the function. Compute the work done using the lefthand, righthand, and trapezoidal rules. The code should return the three solutions.
3. Write code that uses the function from Problem 3 to compute the error between each of the three integration methods and the analytic solution. Use at least 7 different step sizes for each method and determine how the error scales with step size.
4. Write code that integrates sin x between two user-defined limits using the lefthand, righthand and trapezoidal rules. Determine the error in these integrations as a function of the step size.
5. In my own research, I recently was confronted with an integral that looked something like this (the one I actually encountered was somewhat more difficult, but it had many of the same features):

$$\int_0^\infty \frac{(1-e^{-x})}{x(1+x^2)}dx$$

   A. How does the integrand behave near $x = 0$? How does it behave as $x \to \infty$? Find the leading order behaviors near these limits.

   B. Using a computer, it isn't possible to integrate to infinity. The best we can do is integrate up to some "large" number. Let's call this large cutoff value λ. Will it be possible to find a value for λ such that the numerical integral gives approximately the correct answer? Explain.

   C. If the last part was possible, how could you pick a value for λ such that the error due to cutting off the numerical integration was no more than 0.001? What is this value for λ?

   D. Give a physically-reasoned explanation for how you should go about picking the step size Δx to constrain the error by a similar amount. What are the most important things to consider?

   E. Numerically compute the integral and tell what value you find. Tell what values you used for λ and Δx.