PHYS 3340
Spring 2009
TE Coan
Due: 16 Feb '08, 6pm via email.

Homework 3

1. Compute $\int_2^3 \frac{e^x - e^{-x}}{e^x + e^{-x}} x^x \, dx$ using the gsl library. The output should include the answer, the estimated error and the number of intervals or "panels" used in the calculation. Include source code and output in your hw3 answer file.

2. Plot the above integrand within the indicated limits. Include the gnuplot commands in your answer file.

3. Write a program that generates random real numbers uniformly between 25.0 and 37.0. Use the gsl library. Again, include this source code and sample output in your hw3 answer file.

4. Suppose you have 100 drunks. (Some SMU students on a weekend, weekday?) Each drunk takes $10,000$ steps of length l along a straight line. (These are bizarrely talented drunks.) At *each* step, the drunk has *equal* probability of going forward or backward. Calculate via machine computation the *average distance* D a drunk is from his/her starting position at the end of the journey of $10,000$ steps. Express your answer as $D = \alpha l$, where α is some real number that you are calculating. (Don't give me too many decimal points for α.) Electron transport through metals is similar to the "walk" of these drunks (although the electrons travel in three dimensions and vomit less).

5. Gas molecules in thermal equilibrium at a given temperature T have a characteristic speed distribution $f(v)$ given by

$$f(v)\, dv = 4\pi C \exp(-\frac{1}{2}\beta m v^2) v^2 \, dv,$$

where v is the speed of the gas molecule, $C = (\beta m/2\pi)^{3/2}$, $\beta = 1/kT$, and k is Boltzmann's constant. The probability that a molecule has a speed between v and $v + \Delta v$ is just $f(v)\, dv$ and $\int_{-\infty}^{+\infty} f(v) dv = 1$. (You will learn this when you take statistical mechanics.) The *most probable* speed of the molecules $v^* = \sqrt{2kT/m}$ and is the speed that corresponds to the peak of the probability distribution $f(v)$.

a) Plot $f(v)$ in units of v/v^*. This just means change variables and express $f(v)$ in terms of v/v^* and plot the resulting function versus v/v^*. At what value of v/v^* does $f(v)$ peak? Send your plot along with your answer file.

b) What fraction of the gas molecules have a speed within 1% of the most probable? Include code and sample output in your answer file.