PHYSICS 133
HOMEWORK II

This homework is due at the beginning of the fifth class period.

Problem 1

The probability of finding a given object between 0 and 1 is flat. You look for the object 50 times. Each time you find it you record its position in a histogram that divides the region between 0 and 1 into 10 bins. Making use of Poisson statistics, estimate the probability that one or more of the bins will have not yet recorded an event after the 50 trials.

Problem 2

a) Using the programming tool of your choice generate 10 random numbers from a flat distribution between -0.5 and 0.5, and find the mean of these 10 numbers. Consider this mean to be the 'result' of this procedure.

b) Repeat this 10 times and calculate the mean and variance of your 10 results. Is the distance of the mean from 0 about what you would expect? Why?

c) Now repeat it 100 times and calculate the mean and variance. Is the distance of the mean from 0 still about what you would expect? Did the variance change in a way you would expect? Why?

d) Make a histogram of the 100 results. What probability distribution does this distribution approximately represent? In answering this, write down a PDF (probability density function) that has all the correct numbers inserted into the parameters.

Problem 3

Remind yourself about linear least squares fitting in section 3.2 of the lab manual, and then work through the following. In a particle physics experiment, there are six detectors at positions x = 10; 14; 18; 22; 26; and 30cm. These detectors measure the y positions of the trajectory of a charged particle to be 2.02; 2.26; 3.24; 3.33; 3.92; and 4.03 cm, respectively (i.e., the first position is (10,2.02), the second position is (14,2.26), and so on). The errors on the x positions are negligible; the first and last detectors have a y measurement error of ± 0.10 cm, and the rest have a y measurement error of ± 0.30 cm.

(a) Plot the points with their error bars.

(b) Perform a least squares straight-line fit to the data using the form y = a+bx. Find the values of a and b, and plot the resulting line along with the data points and their error

(c) Based on the χ^2 test, evaluate the quality of the fit.