Chemistry 236 -- Quiz 2

Lab Day ____

February 14, 2012 — Least Squares, Probability, and KaleidaGraph

Pledge and signature:

Note: If you want your paper returned folded (*i.e.*, score concealed), please print your name on the back.

1. (7) Consider the probability distribution, $P(x) = c\,x^2$, defined over the range $-1 \le x \le 2$. For this distribution, calculate: (a) the normalization constant, (b) the mean, (c) the variance, and (d) the standard deviation.

   (a) 1/3 (b) 5/4 (c) $11/5 - (5/4)^2 = 51/80$ (d) $(51/80)^{1/2}$

2. (6) (a) If you generate 10^5 random numbers having this distribution, how many are expected to fall within the x range 1.40–1.50? And what is the standard deviation of this value?

   (b) If you now generate 10^6 such random numbers, what do you get in place of your results in 2a?

   (c) Compare the *per cent* standard deviations in a and b.

   (a) 7011 and $(7011)^{1/2}$ (b) 70111 and $(70111)^{1/2}$ (c) 1.19% & 0.38%

3. (5) A quantity x is uncertain by 3.0% and y is uncertain by 4.0%. Give the % uncertainties for z in each of the following cases:

   a. $z = 9/y$ 4 %
   b. $z = 3\,x^4$ 12 %
   c. $z = 1/\sqrt{8x}$ 1.5 %
   d. $z = 5\,x/y^2$ $(73)^{1/2}$ %
   e. $z = 23\,y^2/x$ $(73)^{1/2}$ %

4. (9) **Least Squares and KaleidaGraph.**

   (a) The declining exponential function with a background is a very commonly occurring functional form in the analysis of kinetics data. Write **exactly** what you should enter in the KG Define Fit box to fit your kinetics data to this relation

   a*exp(-b*x) + c; a = (nonzero value); b = (same); c = (same)

   (b) Why are bad initial values likely to give you more problems here than in, say, fitting calibration data to a quadratic polynomial?

   This is a truly **nonlinear** fit, whereas the polynomial fit is algebraically linear (hence guaranteed to converge for any acceptable starting values).

   (c) In one of your KG exercises, you generated 10^4 sums of 12 random numbers. Describe the shape of the resulting histogram, and give the expected mean and standard deviation.

   Very nearly Gaussian, mean 6, st. dev. 1. [mean and σ for **sum** = 12*(values for **avgs** = 1/2 and 1/12).]

   (d) Suppose instead you generated 10^4 sums of 16 random numbers. How would the results change? (Be quantitative.)

   Gaussian, mean 8. st. dev. = $2/3^{1/2}$ [again, both = 16 * (values for avgs = 1/2 and 1/(4 sqrt(12))).]