Homework 5

(Due Date: Monday, Mar. 10)

Problem 1.- The initial activity $N0$ and lifetime τ of a radioactive source are known with an uncertainty of 1% each, $\frac{\sigma_{N_0}}{N_0} = \frac{\sigma_\tau}{\tau} = 1\%$. The activity at any later time *t* is:

$$N(t) = N_0 \exp(-t/\tau)$$

(a) Find the error in terms of t, activity $N0$ and τ.
(b) For what value of (t/τ) do the errors in $N0$ and τ contribute equally to the uncertainty in $N(t)$?

Problem 2.- (Bevington 4.8) The Particle Data Tables list the following eight experimental measurements of the mean lifetime of the K_s meson with their uncertainties, in units of 10^{-10} s. Find the weighted mean of the data and the uncertainty in the mean.

0.8971±0.0021
0.8941±0.0014
0.8929+0.0016
0.8920±0.0044
0.881±0.009
0.8924+0.0032
0.8937±0.0048
0.8958 ±0.0045

Problem 3.- (Bevington 4.9) Eleven students in an undergraduate laboratory combined their measurements of the mean lifetime of an excited state. Their individual measurements are tabulated. Estimates of Mean and Errors are tabulated:

Student	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
$\tau(s)$	34.3	32.2	35.4	33.5	34.7	33.5	27.9	32.0	32.4	31.0	19.8
σ_τ	1.6	1.2	1.5	1.4	1.6	1.5	1.9	1.2	1.4	1.8	1.3

Find the maximum likelihood estimate of the mean and its uncertainty.

Problem 4.- In an experiment to determine the energy of a gamma ray source, an experimenter makes N_1=44 measurements with the apparatus and finds a result $\bar{E}_1$= 1.022 MeV with a spread s_1= 0.010 MeV in the observations. After looking over the data the experimenter realizes that he could improve the equipment to decrease the uncertainty by a factor of 2.5 (s2 = 0.004 MeV) so he makes N_2=12 more measurements that yield a result $\bar{E}_2$= 1.018 MeV.

(a) What is the uncertainty in the mean $\bar{E}_1$ in the first set?
(b) What is the uncertainty in the mean $\bar{E}_2$ in the second set?

(Hint: we can approximate the uncertainty in each of the "N_i" measurements as the uncertainty given by the spread of the particular set.)

(c) If he wishes to combine the measurements, calculate the mean and the uncertainty in the mean of the combined measurements?