PHYS 1140, Fall 2013
Homework 4

Due Wednesday Oct. 9, 4pm
Duane G2B66

1) The period of a pendulum is measured by six students, and they report their values as 2.51, 2.48, 2.51, 2.52, 2.45, and 2.53 seconds, respectively.
    a. What is the average value for the period, T, and the statistical uncertainty (standard error on the mean) for T? State your final answer for Tavg ± δT in standard format.
    b. The students want a statistical uncertainty that is half of what is calculated above. How many total number of measurements will they need to make (including the 6 above), assuming that the spread in their measurements(s) remains the same? State your reasoning in words.

2) You measure a velocity of some particles many thousands of times, and find that the average is 90.7 m/s, and that the standard deviation on an individual measurement is 2 m/s. Now, you take an additional 20 measurements, and take the average just of those 20 measurements. What is the probability that you find that average to be either greater than 91.6 m/s, or less than 89.8 m/s?

3) We have a function $z = x\cos^2(\theta)$. We are interested in how sensitive the function is to the uncertainty δθ for different values of θ.
    a. Take x = 1.203 +/- 0.002 meters, θ = (45.5 +/- 0.5) degrees. Calculate z ± δ z.
    b. Repeat the calculation with x = 1.203 +/- 0.002 meters, θ = (5.5 +/- 0.5) degrees.
    c. Discuss why δz is different for both cases, despite identical uncertainties in x and θ. Use a suitable graph to illustrate your explanation.

4) The power P delivered to a resistance R by an electrical current I is supposed to be given by the relation $P = RI^2$. To check for this relation and possible deviations from this law at high currents (e.g., due to the temperature dependence of R) you measure the dissipated power through a resistor at variable current. You perform this measurement by immersing a resistor (electrically isolated) in a bath of water of known amount and measuring the temperature rise. The following table summarizes the results of your measurements:

Current I (A)	Power P (W)
1.5	270 ± 50
2.0	380 ± 50
2.5	620 ± 60
3.0	830 ± 60
3.5	1280 ± 70
4.0	1600 ± 70

Use these results to make a plot of P vs. I and P vs. I^2, including error bars, where the error in I is negligible. (see the Mathematica program *ErrorLinfit.nb*). Use the second plot to decide if your experimental results are consistent with the expected proportionality of P and I^2.