# PHYSICS 47100EF SPRING 2020 Final Exam

Instructions:

1) You may use any resources you wish, but you must do the actual work.
2) You will be provided with an excel file with data.
    a. The file can be found here: https://gibbs.ccny.cuny.edu/teaching/current/final/data/
    b. Each column has a heading: (e.g., z or A or m). The problems use these names to refer to that column of data. This is not the same as the excel column name.
    c. The second row contains the number of data points in the column.
    d. The data starts on the third row and continues downward.
    e. As an example, if a problem says find the mean of column z, then you would find the column labeled z. If the second row of that column is 10, then rows 3 through 12 would contain the 10 data points used to find the mean.
    f. To check your understanding sum column z in your file. You should get 13.
    g. As an aid, if you use matlab, then the following commands will define a variable containing the data from each column with a name given by the column name from the file 'data.xls':

```
[num,txt,all]=xlsread('data.xls');
[~,c]=size(all);
for n=1:c;
  ln=sprintf('%s=num(2:%d,%d);',txt{1,n},num(1,n)+1,n);
  evalin('base',ln);
end
% sum(z) should give 13
sum(z)
```

3) Email a pdf of your answers to markdshattuck@gmail.com by 11:59 May 22, 2020

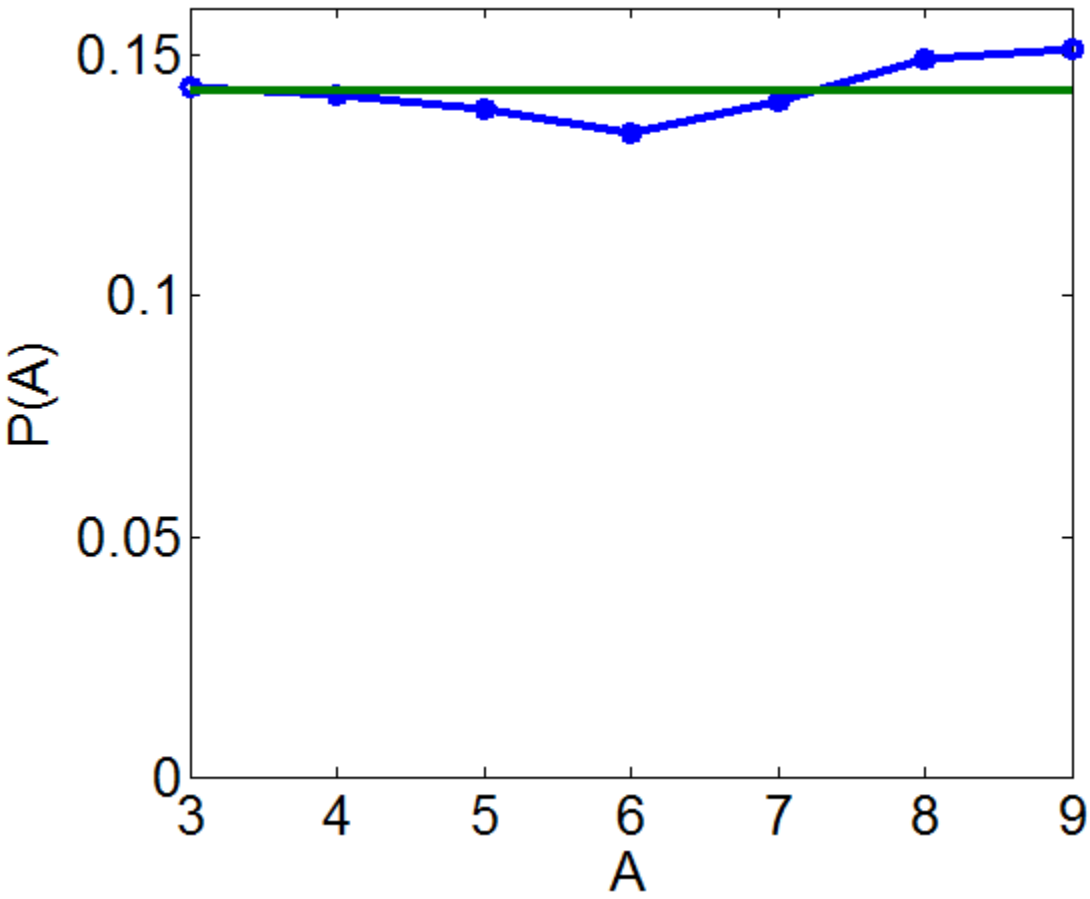
Problems:

0) Include your name and the name of the data file that you will be analyzing.

Example: Mark Shattuck ShattuckM1251016750.xls

1) For each column heading A, B, C answer or do the following:
    a. Is the data discrete (integers) or continuous?
    b. What is the maximum of the data?
    c. What is the minimum of the data?
    d. What is the mean of the data?
    e. What is the standard deviation of the data?
    f. Plot the normalize histogram of the data. The histogram P(x) should be normalized so that the sum of P(x) dx = 1, where dx is the bin size.
        i. Explain how you chose the bin size.
        ii. Identify the most likely type of distribution: Binomial, Normal, Poisson, Uniform, Other.
        iii. Estimate the parameters that define the distribution. For example, Normal distribution with mean X and standard deviation s, Binomial distribution with N trials and probability p, Poisson distribution with mean L, Uniform distribution over the range [a,b], or Other.
        iv. Plot the ideal distribution on the same plot with the data. Use symbols, linestyles, and/or color to clearly identify the data and the ideal distribution.
    g. Give a brief example of how the distribution could arise.

Example:
a) Discrete. b) 9. c) 3. d) 6.04 +/- 0.05 e) 2.025




f) green ideal, blue data. i) bin size = 1 discrete data. ii) Uniform iii) Uniform integers 3-9.

g) add 2 to the roll of a 7-sided dice.

2) For each column pair (Qx, Qy) and (Rx, Ry) assume that the x part of the pair is the independent variable and the y part is the dependent measured variable, where the independent variable is exact, and the dependent variable has experimental uncertainty. For each pair, answer or do the following:
   a. Make 4 plots of each pair. (You will not include all of these in the final document.)
      i. Linear x and linear y.
      ii. Linear x and log y.
      iii. Log x and linear y.
      iv. Log x and Log y.
   b. From the 4 plots choose the one that best summarizes the data (i.e., gives the simplest representation).
   c. Fit the data in the plot chosen in part b to a line.
   d. What is the slope of the line?
   e. What is the y-intercept of the line? Note: y might be Log y if plots ii. or iv. are used.
   f. What is the uncertainty in y?
   g. What is the uncertainty in the slope?
   h. What is the uncertainty in the y-intercept?
   i. What is the linear correlation coefficient R?
   j. What is the probability that uncorrelated variables could have this value of R?
   k. What is the equation relating x and y? (e.g., Ry=1.2*Rx+3 or Qy=7*exp(-Qx/3)).
   l. Plot the fit as a solid line on the same plot with the data as a symbol and indicate the uncertainty. Use a separate plot for each pair. Show a total of 2 plots.
   m. Note: in all parts be sure to use only significant figures.

Example:
d,g) 6.3 +/- 1.0. e,h) 4.5 +/- 2.2. f) 1.8 i) R=0.99 j) <0.0001.
k) Ry=A*log(Rx/Rx0) where A=6.3 +/- 1.0 and Rx0=0.50 +/- 0.18.
l) dashed lines are +/- 1.8.

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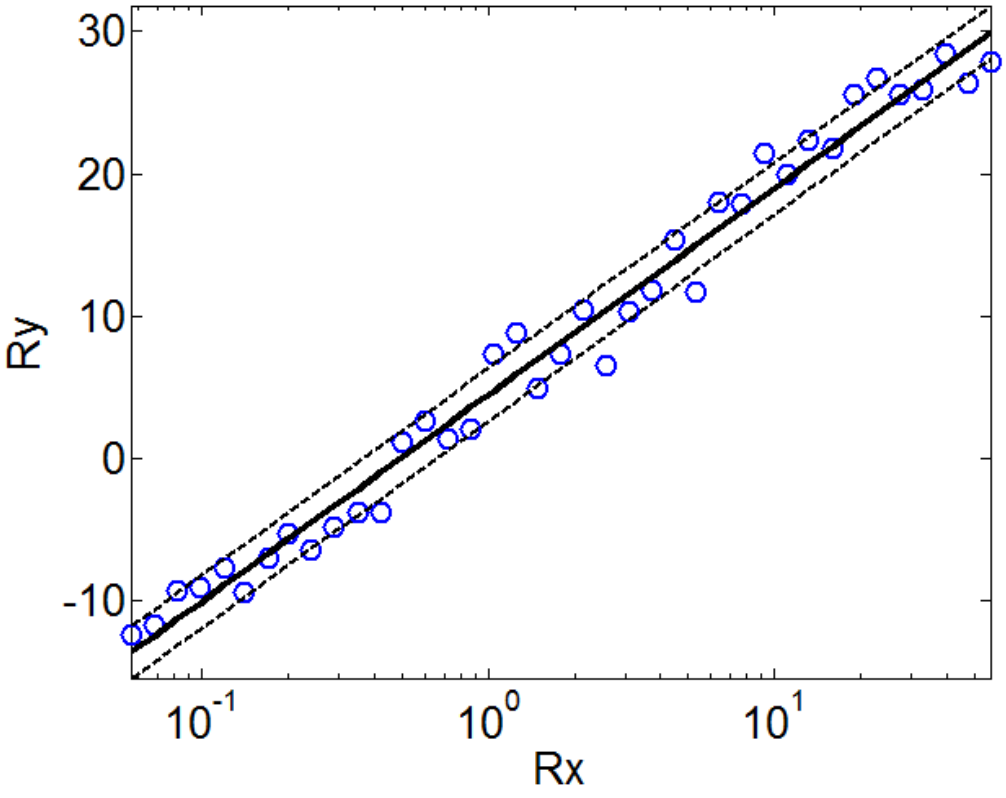

3) Columns U, V, W represent three sets of repeated measurements. Columns K, M, N are exponents in the equation: $Q=U^K V^M W^N$. What is the best estimate for Q including uncertainty? Show your work. (Note: K, M, N only contain one value so the first row will be K or M or N, the second row will be 1 for each and the third row will contain the value.)

Example:
K=1, M=1, N=-1;
Q=UV/W
Mean(U)=3.2
Std(U)=0.4
Count(U)=4;
dU=0.4/sqrt(4)=0.2;

U=3.2 +/- 0.2
V=72.00 +/- 0.02
W=8.12 +/- 0.04

dQ=Q*sqrt((dU/U)^2+(dV/V)^2+(dW/W)^2)=1.8

Q=28 +/- 2

4) If you agree with this statement: “I did all of the work in the file I am turning in.” , then add the statement to the file.