

## PHYSICS 47100EF SPRING 2021 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](mailto:markdshattuck@gmail.com) by 11:59 May 24, 2021

### Problems:

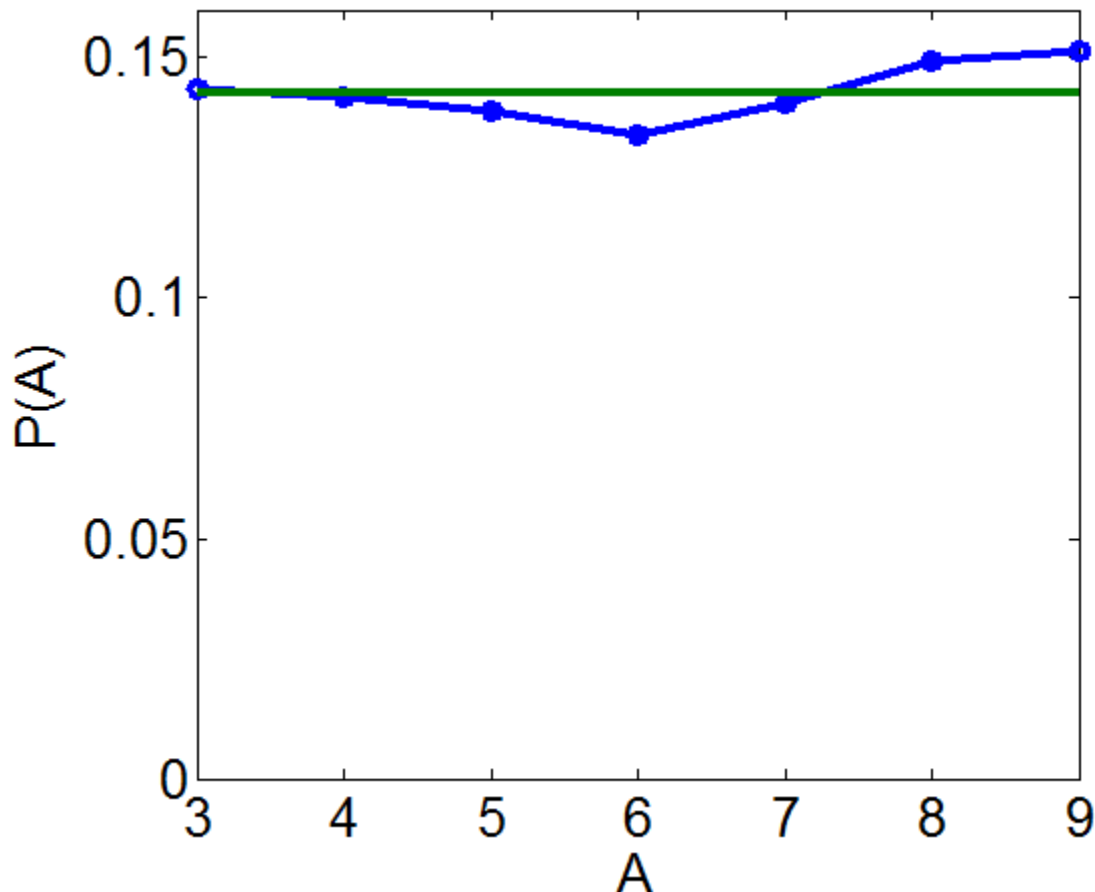
- 0) Include your name and the name of the data file that you will be analyzing.

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 normalized 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

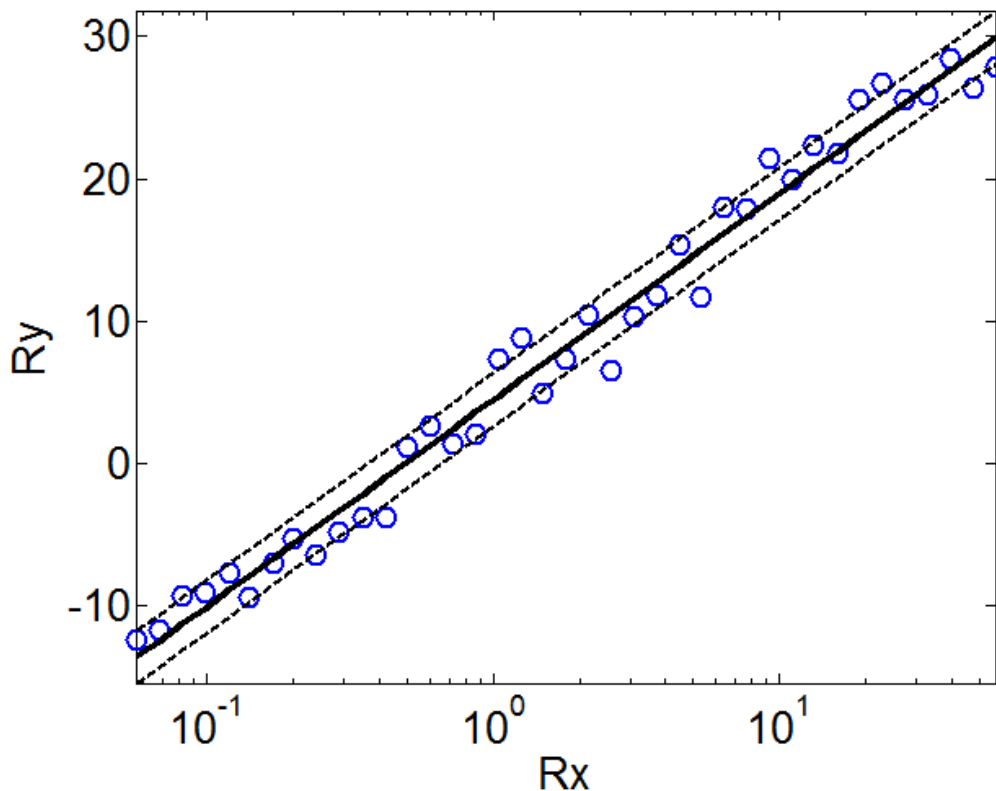


f) green ideal, blue data. i) bin size = 1 discrete data. ii) Uniform iii) Uniform integers 3-9.

- g) add 2 to the roll of a 7-sided dice.
- 2) For each column pair ( $Q_x, Q_y$ ) and ( $R_x, R_y$ ) 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:
- Make 4 plots of each pair. (You will not include all of these in the final document.)
    - Linear x and linear y.
    - Linear x and log y.
    - Log x and linear y.
    - Log x and Log y.
  - From the 4 plots choose the one that best summarizes the data (i.e., gives the simplest representation).
  - Fit the data in the plot chosen in part b to a line.
  - What is the slope of the line?
  - What is the y-intercept of the line? Note: y might be Log y if plots ii. or iv. are used.
  - What is the uncertainty in y?
  - What is the uncertainty in the slope?
  - What is the uncertainty in the y-intercept?
  - What is the linear correlation coefficient R?
  - What is the probability that uncorrelated variables could have this value of R?
  - What is the equation relating x and y? (e.g.,  $R_y = 1.2 \cdot R_x + 3$  or  $Q_y = 7 \cdot \exp(-Q_x/3)$ ).
  - 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.
  - Note: in all parts be sure to use only significant figures.

Example:

- d,g)  $6.3 \pm 1.0$ . e,h)  $4.5 \pm 2.2$ . f) 1.8 i)  $R = 0.99$  j)  $< 0.0001$ .  
 k)  $R_y = A \cdot \log(R_x/R_{x0})$  where  $A = 6.3 \pm 1.0$  and  $R_{x0} = 0.50 \pm 0.18$ .  
 l) dashed lines are  $\pm 1.8$ .



- 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:

$K=1, M=1, N=-1$ ;

$Q=UV/W$

$\text{Mean}(U)=3.2$

$\text{Std}(U)=0.4$

$\text{Count}(U)=4$ ;

$dU=0.4/\text{sqrt}(4)=0.2$ ;

$U=3.2 \pm 0.2$

$V=72.00 \pm 0.02$

$W=8.12 \pm 0.04$

$dQ=Q*\text{sqrt}((dU/U)^2+(dV/V)^2+(dW/W)^2)=1.8$

$Q=28 \pm 2$

- 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.