

Physics 336  
HW6

1. Assess random number generators in Mathematica and Python, to see if they perform as expected
  - (a) uniformly-distributed random numbers.
  - (b) Gaussian-distrubuted random numbers.
  - (c) Poisson-distributed random numbers.

**For the following problems, do at least two of them using Mathematica, and at least two using Python.**

2. Consider rolling  $N$  fair dice, each with  $f$  faces, with the outcome being the total of the numbers shown by each of the dice. The result will be between  $N$  (if all ones are showing) and  $N \cdot f$  (if all  $f$ 's are showing). For example, if 3 six-sided dice are rolled, the total can be as low as 3 and as high as 18.
  - (a) Consider 2 six-sided fair dice. Use random numbers to predict the probabilities of each outcome.
    - i. Plot your results.
    - ii. Does a triangular-shaped probability density function fit your results well?
    - iii. Does a Gaussian fit well?
  - (b) Repeat for 4 six-sided dice.
  - (c) repeat for 10 six-sided dice.
  - (d) Try some other situations, such as 6 four-sided dice, or 3 ten-sided dice.
3. Use your results from Problem 2 to calculate the probability of getting between
  - (a) 6 and 8, when using 2 fair six-sided dice.
  - (b) 12 and 16 when using 4 fair six-sided dice.
4. Rework Problem 2 using unfair dice that have probabilities  $P(4) = P(5) = P(6)$  and  $P(1) = 4P(6)$ ,  $P(2) = 3P(6)$ , and  $P(3) = 2P(6)$ .
5. Consider a radiation counting experiment where the time interval is short enough that  $\mu = 1.0$ , and for this case 1000 measurements are made. For  $\mu$  this small, a significant number of the results will be zero. Model this process using random numbers to investigate the following questions.
  - (a) How many of the 1000 results are expected to be zero?
  - (b) What is the probability of 5 consecutive zeros?

- (c) How many sequences of at least 5 consecutive zero results are expected?
  - (d) How many 1's are expected? Do the number of 1's follow a Gaussian distribution?
6. Simulate an ideal gas in a container of volume  $V_{total}$ , and determine the fraction of atoms that are within some subvolume  $V < V_{total}$
- (a) in one dimension.
  - (b) in two dimensions.
  - (c) in three dimensions.
  - (d) Comment on your results.
7. Invent a situation and generate some simulated data for it.