

Homework week 4 (Part B) Due Monday Chemistry 455A
Homework for chapter 3.

In class we discussed the measurement of the number of chips in chocolate chip cookies.

- 1) Ten cookies are broken up to determine the number of chips inside them. The ten measurements are: 8, 14, 12, 14, 16, 14, 14, 10, 14, 16.
 - a) What is the average number of chips in each of the cookies?
 - b) What is the probability of measuring 14 chips?
 - c) Draw a Histogram of the probability distribution for all possible values of chips between 7 and 17.

- 2) Assume that only even numbers of chips can be measured between 8 and 16 (inclusive).
 - a) What is the complete list of all possible values of the observable number of chips?
 - b) What is the Number Operator, \hat{N} , for the number of chips?
 - c) Explain this relation of the operator and observables in the language of postulates 2 and 3.
 - d) Define the eigenfunctions for the 10 chip and 12 chip cookies. φ_n or $|n\rangle$
 - e) Show that the two eigenfunctions give 10 and 12 when operated on by the number operator and explain how this is an eigenvalues problem.
 - f) Show by example (using the 10 and 12 chip wave functions) that the wave functions corresponding to different values (eigenvalues) of an observable (in this case the number of chips) are orthonormal.

- 3) If in a bag of cookies you know that 75% (*i.e.* 3/4) of the cookies contain 10 chips and 25% contain 12 chips, compute (use standard rules of measurement to compute them):
 - a) What is the wave function for each and every cookie in this bag of cookies as a superposition of the eigenfunctions for the number of cookies? In general the function is expanded in terms of the eigenfunctions of an observable (in this case the number of chips): $\Psi = \sum_{n=8} c_n \varphi_n$. The $\{c_n\}$ are the coefficients in the expansion. Take advantage of what you know about the ones that cannot be present in the bag. What are the coefficients?
 - b) Show that your wave function is normalized.

- 4) Use the 4th postulate of quantum mechanics (and the wave function in question three) to compute the mean number of chips.