Name:_____

Biology 3820
Physical Principles in Biology
Fall Semester 2015

Quiz 2
23 September 2015

Please write your name on each page.
Be sure to show your work and include correct units in all of your answers!
25 points total.

1. (15 pts) Back in 2011, there was a gentleman who decided to get his exercise by taking a daily random walk. Each day, he stepped outside to the sidewalk and flipped a coin. If the coin showed heads he turned right, and if it showed tails he turned left. After each step, he flipped the coin again. If the coin showed heads, he continued in the same direction, but if it showed tails, he turned around and took a step in the opposite direction. Each of his steps is 1 meter long. After doing this for a year and recording the distance that he had traveled from his house at the end of the walk, he found that the RMS distance was about 10 m. A student then taking Biol. 3820 happened to live next door to him, and the student confirmed that this was the theoretically expected result.

   After another year or so of this, the gentleman started getting bored and came up with a new variation on his random walk routine. Now, instead of a coin, he carries a single six-sided die with him on his walk. But, this is a special die, with the numbers -3, -2, -1, 1, 2 and 3 embossed on its sides. At the beginning, he rolls the die. If one of the positive numbers shows, he takes that number of steps eastward. If a negative number appears, he takes the indicated number of steps (1, 2 or 3) westward. After taking these steps, he rolls the die again and takes steps as indicated by the result. The length of his steps have remained 1 m. For each daily walk, he rolls the die 100 times, but the number of steps he takes varies from day to day.

   (a) Calculate the average number of steps that the man takes (in either direction) per roll of the die.

Name:_____

(b) Calculate the average number of steps that the man takes per day.

(c) We will call the displacement towards the east for each roll of the die δ. (i.e., δ equals the number that shows on the die.) Calculate the following averages: $\langle\delta\rangle$, $\langle\delta^2\rangle$ and RMS(δ).

(d) Calculate the RMS distance that the man ends from his house, over a large number of walks, assuming 100 rolls of the die per walk.

(e) Suppose that the man wants the end points of his walks to have an RMS distance from his house of 100 m. How many times should he roll the die for each walk? What is the average number of steps he will take per day?

Name:_____

2. (10 pts) On the ruled lines below, write Python code to define a function, `dieWalk(n)` to simulate a random walk such as described in the first problem. The function should accept a single variable, `n`, to specify the number of times the die is rolled for an individual walk. It should return a value, x, that represents the final position, relative to the starting position, where $x = 0$. If the function requires any functions from other Python modules, your code should include the statements necessary to import those modules before the function definition. If `dieWalk(n)` requires any functions of your own, those functions should be defined before the definition of `dieWalk(n)`. Use the vertical dashed lines to align indented code. If you need more lines than provided below, you are making things too difficult!