Manhattan Project — Assignment 9

1. Reed Problem 7.5 — Trinity Test

For this problem, you need the height that the Trinity test was conducted at was d_2 =100 feet, the height that the calibration test was conducted at was d_1 =28 feet, and the power of the Trinity test was expected to be equivalent to E_2 =20,000 tons of TNT.

Don't plug these numbers in until the end!

First write down the equation for the pressure twice:

$$P_1 = c\,\frac{{E_1}^{2/3}}{{d_1}^2}$$

$$P_2 = c\,\frac{{E_2}^{2/3}}{{d_2}^2}$$

Then do what the problem asks which is to demand $P_1 = P_2$. Simplify. Solve for the unknown E_1.

Now plug the numbers into your equation for E_1!

2. Reed Problem 7.9 — Fallout — Immediate Radioactivity

You have two fission products with half-lives t_1 and t_2, and initial amounts a_1 and a_2.

I think that Reed wants us to find the number of decays per second using Eqs. 2.2 and 2.3 on p. 26.

It would be good to convert this to Curies using Eq. 2.7.

To get a sense of how this is decreasing with time, make a table of values for the times:

1.08 seconds
10.8 seconds
1.8 minutes
18 minutes
3 hours

I chose these table values to each be 10x as much as the previous values and to cover the range from less than the shorter half-life to much longer than the longer half-life.

3. Random Walks — Mean and Standard Deviation

Download the spreadsheet:

http://brianhill.github.io/manhattan-project/assignments/Assignment09.numbers

The first rows give the probability of a random walk of 7 steps.

(a) Calculate the mean motion using the formula:

$m = \sum_{i=-7}^{+7} p_i \, x_i$

SUGGESTION: First, make a new row that is $p_i \, x_i$. Second, apply the SUM function to all the values in this row.

DISCUSSION: Of course, this is going to come out to zero, but it is a good first step.

(b) Calculate the standard deviation using the formula:

$\sigma^2 = \sum_{i=-7}^{+7} p_i \cdot (x_i - m)^2$

SUGGESTION: First, make a new row that is $(x_i - m)^2$. Of course, since $m = 0$, you could simplify that to x_i^2. Second, make a row that is p_i times this row. Third, apply the SUM functions to all the values in this row. Finally, take the square root to get σ.

DISCUSSION: We are only doing 7 steps, but the result for σ should be about $\sqrt{7}$. After N steps, where N is large, you get $\sigma = \sqrt{N}$. This is one of the first results of probability theory and diffusion theory.

4. Random Walks — Graphing

(a) Insert a graph into the spreadsheet that graphs x_i on the horizontal axis and p_i on the vertical axis.

(b) Insert another graph into the spreadsheet that graphs x_i on the horizontal axis and ln p_i on the vertical axis (ln is short for natural log).

DISCUSSION: For large N the probability is proportional to $e^{-x_i^2/\sigma^2}$. By taking the natural log, we should see the beginnings of a downward-opening parabola, even though we only have $N = 7$.

PHILOSOPHICAL QUESTION: Is 7 a large number?