Problem Set 9 Solution

Problem 1 Shock-wave pressure

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

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

Demand P_1 for calibration test $= P_2$ for Trinity test

$$\cancel{C}\frac{E_1^{2/3}}{d_1^2} = \cancel{C}\frac{E_2^{2/3}}{d_2^2}$$

Solve for E_1

$$E_1^{2/3} = d_1^2\frac{E_2^{2/3}}{d_2^2}$$

$$E_1 = \left(d_1^2\frac{E_2^{2/3}}{d_2^2}\right)^{3/2}$$

$$= \left(\frac{d_1}{d_2}\right)^3 E_2 = \left(\frac{28\cancel{ft}}{100\cancel{ft}}\right)^3 20{,}000 \text{ tons}$$

$$= 439 \text{ tons for the calibration test}$$

Problem 2 Fallout

t_1 = half-life of Barium-141 = 18 min

t_2 = half-life of Krypton-92 1.8 sec

$a = a_1 = a_2$ = initial number of atoms

$$= \frac{1000\text{g} \times 6.02\times10^{23}\ \text{atoms/gram}}{235.04\text{u}} \text{ 1u}$$

(1u: conversion factor for an atom weighing 1u)

$$= 25.61\times10^{23} \text{ atoms}$$

λ_1 = decay constant for Barium

$$= \frac{\ln 2}{t_1} = \frac{\ln 2}{1080\text{ s}} = 0.000642\ \frac{1}{\text{s}}$$

$$\lambda_2 = \frac{\ln 2}{1.8\text{s}} = 0.385\ \frac{1}{\text{s}}$$ ← By Eq. 2.2

$$R_1(t) = -\lambda_1 a_1 e^{-\lambda_1 t}$$

$$R_2(t) = -\lambda_2 a_2 e^{-\lambda_2 t}$$ ← By Eq. 2.3

TABLE IS IN SPREADSHEET

Table for Problem 2

	lambda	0.000642	0.385	curies conversion factor	3.7E+10	
	initial number	2.561E+24	2.561E+24		square meters in 10 sq miles	2.589988110336E+07
		R1(t)	R2(t)	TOTAL = R1(t)+R2(t)	TOTAL IN CURIES	**TOTAL IN CURIES PER SQUARE METER**
108ms	0.108	1.6E+21	9.5E+23	9.5E+23	2.6E+13	**9.9E+05**
1s 80ms	1.08	1.6E+21	6.5E+23	6.5E+23	1.8E+13	**6.8E+05**
10s 800ms	10.8	1.6E+21	1.5E+22	1.7E+22	4.6E+11	**1.8E+04**
1m 24s	108	1.5E+21	8.6E+05	1.5E+21	4.1E+10	**1.6E+03**
18m	1080	8.2E+20	2.6E-157	8.2E+20	2.2E+10	**8.6E+02**
3h	10800	1.6E+18	0.0E+00	1.6E+18	4.3E+07	**1.7E+00**

Problem 3: Mean, and Standard Deviation of a Random Walk

Final Position, x_i	-7	-5	-3	-1	1	3	5	7
Probability, p_i	0.0078	0.0547	0.1641	0.2734	0.2734	0.1641	0.0547	0.0078
Log Probability, ln p_i	-2.1072	-1.2621	-0.7850	-0.5631	-0.5631	-0.7850	-1.2621	-2.1072
pi * xi	-0.0547	-0.2734	-0.4922	-0.2734	0.2734	0.4922	0.2734	0.0547
Mean	0.0000							
pi * (xi-m)^2	0.3828	1.3672	1.4766	0.2734	0.2734	1.4766	1.3672	0.3828
sigma^2	7.0000							
sigma	2.6458							

Problem 4: Graphing Probability Distributions