# <u>The Decay of "Blockium "</u>

The rate at which a radionuclide decays can be measured by counting the number of nuclei that disintegrate per unit time. This decay process is first order. In other words, the rate of decay is directly proportional to the amount of radionuclide remaining and can be represented by the following relationship:

$$\mathbf{R_t = ?\ N_t}$$

Where $R_t$ is number of nuclei decaying per unit time, ? is the decay constant or the probability of a nucleus decaying per unit time, and $N_t$ is the amount of radionuclide remaining at time t. Applying first order rate law we can also relate the amount of radionuclide remaining at any time, $N_t$, to the amount of radionuclide we began with, $N_o$ via the expression:

$$\mathbf{N_t = N_o e^{-(?t)}}$$

When half the original amount of radio nuclide remains, $N_t = 1/2\ N_o$ and $N_o/N_t = 2$. The time it takes for one-half of the original amount of radio nuclide to decay is called the half-life, $t_{1/2}$ . At $t_{1/2}$, the above expressions can be rewritten as follows:

$$\mathbf{0.693 = ?\ t_{1/2}}$$

You will be given a sample of "Blockium" to study and your objectives are to determine the decay constant and the half-life of this radionuclide.

**Procedure**

1. Determine the number of "Blockium" nuclei that are present (your instructor may provide this information).

2. Choose one of the six colors that adorn a side of each "Blockium" nucleus and record this in your data table.

3. Our unit of time will be "the roll" (like with dice).

4. Put your "Blockium" sample in the container provided and roll them out, keeping in mind that the amount of scatter will be related to the force with which you propel the nuclei out of the container.

5. Remove and count all the nuclei with your chosen color facing up. Record this value in your data table.

6. Repeat steps four and five until your entire sample has decayed or you fill your data table.

7. Using your graphing calculator plot the number of radionuclides remaining vs. time, and the number of decays vs. time. Make a large sketch of each graph (including labeled axes, units, etc.) Describe the shape of each graph in mathematical words. Indicate clearly on each graph the first half-life, second half-life, third half-life, etc.

8. Determine $t_{1/2}$., and then ?, from your graphs. Then use your calculator to do an appropriate fit to all the data for each graph. Report the results of your fits using the usual matching table formats. Use your fit values to determine the half life and decay constants again. How do the results compare with the values you got in step 7 ?

Color Chosen______________________

| Roll | Number of Blockium Rolled | Number of Decays |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |
| 11 | | |
| 12 | | |
| 13 | | |
| 14 | | |
| 15 | | |
| 16 | | |
| 17 | | |
| 18 | | |
| 19 | | |
| 20 | | |
| 21 | | |
| 22 | | |
| 23 | | |
| 24 | | |
| 25 | | |
| 26 | | |
| 27 | | |
| 28 | | |
| 29 | | |
| 30 | | |

Average Values obtained from graphs:

? = __________ $t_{1/2}$ = _________

Graph of number of radionuclides remaining vs. time:

Matching Table:

Values obtained from fit constants:

? = __________ $t_{1/2}$ = _________

Graph of number of decays vs. time:

Matching Table:

Values obtained from fit constants:

? = ___________ $t_{1/2}$ = __________