

Working With Half-Life

When radioactive materials decay they release high speed particles that bang into other unstable radioactive atoms, hastening their decay. As the process proceeds, the amount of radioactive material decreases. This causes the number of high speed emissions to decrease. The fewer emissions there are, the slower the decay process becomes. As a result, large samples of radioactive material decay at a faster rate than small samples. In fact, as the sample size decreases, the rate of decay slows in such a way that the amount of time it takes for half the sample to decay is constant regardless of the sample size. In other words, it takes 500 g of uranium the same amount of time to decay into 250 g of uranium as it does for 2 g of uranium to decay into 1 g of uranium. The amount of time it takes for a radioactive sample to decay to half its original mass is called the half-life.



The easiest way to solve half life problems is to set up a table.

Sample Problem

How much ^{42}K will be left in a 320 g sample after 62 h?

Step 1: Look up the half life in *Table N*, the table of Selected Radioisotopes 12.4 h

Step 2: Set up a table showing the mass, time elapsed, the fraction remaining, and number of half lives starting with the initial conditions and ending when the full time has elapsed. For each half life elapsed, cut the mass in half, increase the time by an amount equal to the half life, cut the fraction in half, and add one to the number of half lives.

Mass	Time	Fraction	Half lives
320	0	1	0
160	12.4	$\frac{1}{2}$	1
80	24.8	$\frac{1}{4}$	2
40	37.2	$\frac{1}{8}$	3
20	49.6	$\frac{1}{16}$	4
10	62	$\frac{1}{32}$	5

Following this procedure it is possible to determine the final mass, the time elapsed, the fraction of the original sample, or the number of half lives elapsed.

Answer the questions below using data from *Table N*, the table of *Selected Radioisotopes*.

- How long will it take for 30 g of ^{222}Rn to decay to 7.5 g?
- How many grams of ^{16}N will be left from a 16 g sample after 21.6 s?

