

Half-Life

Aim

- to explain half-life and solve half-life problems

Notes

Half life

- ★ Definition - the amount of time it takes for half of a radioactive sample to decay
- ★ Explanation
 - ☆ During radioactive decay, high speed particles are emitted that bang into other atoms and cause them to decay
 - ☆ As a sample decays the amount of radioactive material decreases
 - ☆ As the size of the radioactive sample decreases, the number of particles emitted decreases
 - ☆ As the number of particles emitted decreases, the number of collisions decreases and radioactive decay slows down
 - ☆ Radioactive decay slows down over time in such a way that the amount of time it takes for half a sample to decay is constant regardless of the size of the sample
- ★ Radioactive dating
 - ☆ Carbon dating
 - ★ Carbon-14 is radioactive and has a half life of 5,700 years
 - ★ Carbon dioxide in the air contains carbon-14
 - ★ Plants take in carbon dioxide and make carbohydrates as long as they are alive
 - ★ Animals eat plants as long as they are alive
 - ★ As soon as an organism dies, it stops taking in carbon, so its amount of c-14 begins to decrease
 - ☆ Uranium dating
 - ★ Uranium-238 is radioactive and has a half life of 10^9 years
 - ★ Uranium-238 is found in igneous rock
 - ★ Uranium-238 decays into lead
 - ★ After the rock cools, the amount of uranium-238 in the rock begins to decrease and the amount of lead begins to increase
 - ★ the fraction of uranium left can be determined by comparing its mass to the mass of the lead
 - ☆ number of half lives and time elapsed
 - T_e = Time elapsed
 - $t_{1/2}$ = $\frac{1}{2}$ life
 - n = number of $\frac{1}{2}$ lives
 - f = fraction left
 - $f = (\frac{1}{2})^n$ $T_e = n(t_{1/2})$
 - ★ Half Life Problems
 - ★ Half life problems of all types are best solved by setting up a table that shows the *number of half lives*, the *mass*, the *time elapsed*, and the *fraction left*. (any of these 4 variables can be the unknown)
 - ★ Half lives of many elements are listed in *Table N*

Sample Problem

An ore that once contained 320 g of ^{60}Co now contains only twenty grams of the radio active material. How long has it been decaying?

Step 1: divide the mass in half repeatedly until it is reduced from 320 g to 20 g

Step 2: look up the half life and fill in the rest of the table

number of half lives	mass	time elapsed	fraction left
0	320 g	0	1 (100 %)
1	160 g	5.26 y	1/2
2	80 g	10.52 y	1/4
3	40 g	15.78 y	1/8
4	20 g	21.04 y	1/16

Answer the questions below by circling the number of the correct response

- How much of an 8 gram sample of $^{226}_{38}\text{Ra}$ will remain unchanged at the end of 3 half-life periods?
(1) 1 g (3) 3 g
(2) 2 g (4) 4 g
- What is the total mass of a 10. gram sample of ^{42}K that will remain unchanged after 12.4 hours?
(1) 2.5 g (3) 7.5 g
(2) 5.0 g (4) 10. g
- As the temperature of a radioactive sample increases, the rate of nuclear decay
1 decreases
2 increases
3 remains the same
- A sample contains 100 milligrams of iodine-131. At the end of 32 days, the number of milligrams of iodine-131 that will remain will be
(1) 25.00 (3) 6.250
(2) 12.50 (4) 3.125
- Approximately how many grams of a 40-gram sample of $^{131}_{53}\text{I}$ will remain unchanged after 24 days?
(1) 5 (3) 13
(2) 10 (4) 20
- How much of an 8 gram sample of $^{226}_{38}\text{Ra}$ will remain unchanged at the end of 3 half-life periods?
(1) 1 g (3) 3 g
(2) 2 g (4) 4 g
- What is the number of half-life periods required for a sample of a radioactive material to decay to $1/16$ of its original mass?
(1) 8 (3) 3
(2) 16 (4) 4
- As a sample of the radioactive isotope ^{131}I decays, its half-life
(1) decreases
(2) increases
(3) remains the same
- Exactly how much time must elapse before 16 grams of potassium-42 decays, leaving 2 grams of the original isotope?
(1) 8×12.4 hours (3) 3×12.4 hours
(2) 2×12.4 hours (4) 4×12.4 hours