Half-life

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Half-life is the time in which a value is exponentially reduced to half its initial value. In case of exponential increase this is called doubling time or generation time (in biology).

The quantity of a substance that remains after one half-life is reduced again to half its value during the next half-life, i.e. it remains 1/2·1/2=1/4; after 3 half-lives 1/8, then 1/16, 1/32, 1/64 and so on.

In physics, **radioactive half-life** describes the time after half of a certain number of radioactive atom nuclei have decayed (radionuclide, radioactivity). At the end of a half-life cycle the quantity as well as the activity of a radioactive substance have been reduced to half the initial value. Every radionuclide has its own characteristic half-life that might reach from split seconds to billions of years. Artificial radionuclides (nuclear power plant) with long half-lives pose a special danger; they have to be kept away from the environment with great care for tens of thousands of years.

Biological half-life, also plasma half-life, is the time period after which an organism has excreted half the quantity of a substance fed to it (incorporation) through metabolic processes. Taking appropriate foodstuffs (e.g. foods containing iodine in case of radioactive iodine) or chemical substances can reduce the retention time of radioactive substances in the body. In general, biological half-life can refer to all substances that enter the human body.

Effective half-life: if a radioactive substance is fed to an organism the amount of radioactive nuclides of this substance is reduced by radioactive decay on the one hand and by excretions on the other hand. The effective half-life considers both variables and thus describes the time period after which the endangering of the organism has been reduced to half the initial value. Effective half-life = radioactive_half-life x biological half-life/ (radioactive_half-life + biological half-life).

Example:

The radioactive iodine isotope I-131 has a radioactive half-life of 8.07 d and a biological half-life of 138 d. This leads to an effective half-life of 8.07 x 138/(8.07 + 138) = 7.6 d.

Mass k after n years:

$$k_n = k_0 * e^{-w*n}$$

k	mass	
n	years	
w	Ln (1-p/100)	half-life is n_h = (ln 2) / w
p	decay rate	

Half-life :

Half-life $T_{1/2}$ is linked to the decay rate through

$w \cdot T_{1/2} = \ln(2)$

$w = \ln(2) / T_{1/2}$

Half-lives of some radioactive isotopes :

- Uranium (238 U): 4.5. billion years
- Carbon (14C): 5730 years
- Radium (236 Ra): 1622 years
- Thorium (223 Th): 0.9 seconds