Radioactive decay

General equation

The decay rate of a substance is proportional to the amout of the original substance, leading to the differential equation:

$$-\frac{dN}{dt} = \lambda N$$

Solving this equation gives the solution:

$$N = N_0 e^{-\lambda t}$$

where:

- N_0 = original amount of substance
- N = amount of substance after time t
- t = time
- λ = decay constant

half life - amount of time that needs to pass for half of the original substance to remain

to find half life- solve this equation for $T_{1/2}$

$$\frac{N_0}{2} = N_0 e^{-\lambda T_{1/2}}$$

solution:

$$T_{1/2} = \frac{0.693}{\lambda}$$

if you know the half life of a decay, you can find λ

Activity - magnitude of the decay rate

$$A = -\frac{dN}{dt} = \lambda N = \lambda N_0 e^{-\lambda t}$$

Types of radioactive decay

source: table 17.3.1 of [2]

particle	description	symbol	mass	penatrating power	ionizing power	shielding

particle	description	symbol	mass	penatrating power	ionizing power	shielding
Alpha	helium nucleus	α	4 amu	very low	very high	paper / skin
Beta	electron	β	1/2000 amu	intermediate	intermediate	aluminum
Gamma	high energy photon	γ	energy only	very high	very low	2 inches lead

Refs

- [1] https://phys.libretexts.org/Bookshelves/University_Physics/Book%3A_University_Physics_(OpenStax)/University_Physics_III_-_Optics_and_Modern_Physics_(OpenStax)/10%3A__Nuclear_Physics/10.04%3A_Radioactive_Decay
- [2] https://chem.libretexts.org/Courses/can/intro/17%3A_Radioactivity_and_Nuclear_Chemistry/17.03%3A_Types_of_Radioactivity%3A_Alpha_Beta_and_Gamma_Decay