

lifetime, τ

Also contains definition of: mean lifetime, τ

Lifetime of a molecular entity, which decays by first-order kinetics, is the time needed for a concentration of the entity to decrease to $1/e$ of its original value, *i.e.*, $c(t = \tau) = \frac{c(t=0)}{e}$. Statistically, it represents the life expectation of the entity. It is equal to the reciprocal of the sum of the first-order rate constants of all processes causing the decay of the molecular entity.

Notes:

1. Mathematical definition: $\tau = \frac{1}{k} = \frac{1}{\sum_i k_i}$ with k_i the first-order rate constants for all decay processes of the decaying state.
2. Lifetime is used sometimes for processes, which are not first order. However, in such cases, the lifetime depends on the initial concentration of the entity, or of a quencher and, therefore, only an initial or a mean lifetime can be defined. In this case it should be called *decay time*.
3. Occasionally, the term *half-life* ($\tau_{1/2}$) is used, representing the time needed for the concentration of an entity to decrease to one half of its original value, *i.e.*, $c(t = \tau_{1/2}) = \frac{c(t=0)}{2}$. For first-order reactions, $\tau_{1/2} = \ln 2 \tau$.

Source:

PAC, 2007, 79, 293 (*Glossary of terms used in photochemistry, 3rd edition (IUPAC Recommendations 2006)*) on page 363