Important Equations for First-Order Reactions

Terms

$[A]$ = concentration of A at some elapsed time, t

$[A]_o$ = concentration of A at an initial point in the reaction, at time $t = 0$

k = rate constant for the reaction, in units of $(\text{time})^{-1}$

$t_{1/2}$ = half-life period; time required for the concentration of A to fall to half the value it had at the beginning of the half-life period; i.e. time it takes for $[A] = \frac{1}{2}[A]_o$

h = number of half-life periods elapsed = $t/t_{1/2}$

Equations

Differential rate law (*Rate* vs. concentration):

$$Rate = k[A]$$

Integrated rate law (concentration vs. time):

$$\ln\frac{[A]_o}{[A]} = kt \qquad \ln\frac{[A]}{[A]_o} = -kt$$

$$\ln[A] = -kt + \ln[A]_o$$

A plot of ln[A] vs. time is a straight line whose slope is $-k$ and whose intercept is $\ln [A]_o$.

Half-life:

$$[A] = [A]_o(\tfrac{1}{2})^h$$

$$t_{1/2} = 0.693/k$$

Important Equations for Radioactive Decay

Terms

N_t = number of radioactive atoms at some elapsed time, t

N_o = number of radioactive atoms at an initial point, at time $t = 0$

λ = decay constant in units of $(\text{time})^{-1}$ (analogous to k)

A = decay activity in units of disintegrations per time per gram (analogous to *Rate*)

$t_{1/2}$ = half-life period; time required for N_t to fall to half the value it had at the beginning of the half-life period; i.e. time it takes for $N_t = \frac{1}{2}N_o$

h = number of half-life periods elapsed = $t/t_{1/2}$

Equations

Radioactive decay law (analogous to differential rate law):

$$A = \lambda N$$

Time dependence of N (analogous to integrated rate law):

$$\ln\frac{N_o}{N_t} = \lambda t \qquad \ln\frac{N_t}{N_o} = -\lambda t$$

$$\ln N_t = -\lambda t + \ln N_o$$

A plot of $\ln N_t$ vs. time is a straight line whose slope is $-\lambda$ and whose intercept is $\ln N_o$.

Half-life:

$$N_t = N_o(\tfrac{1}{2})^h \qquad \text{and} \qquad A_t = A_o(\tfrac{1}{2})^h$$

$$t_{1/2} = 0.693/\lambda$$