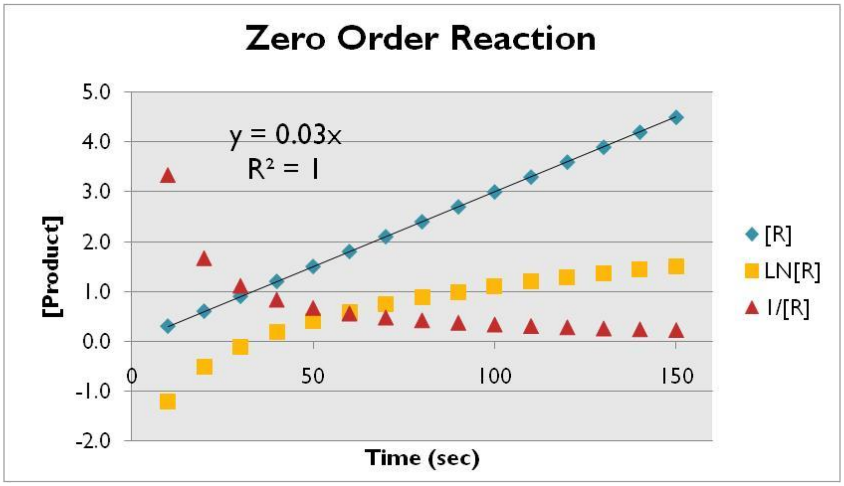
Zero-Order Reactions

If a reaction (R $\longrightarrow$ products) is zero order, the rate equation is

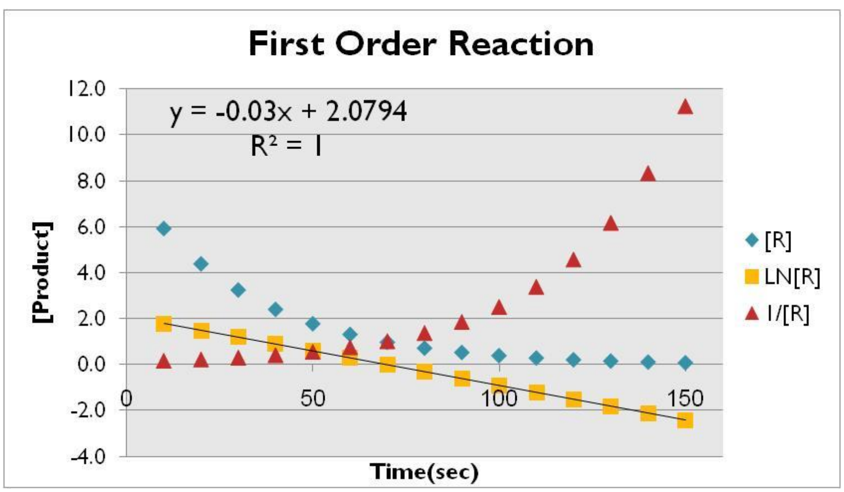
$$-\frac{\Delta[\mathrm{R}]}{\Delta t} = k[\mathrm{R}]^0 \qquad [\mathrm{R}]_0 - [\mathrm{R}]_t = kt$$



First-Order Reactions

Suppose the reaction "R $\longrightarrow$ products" is first order.

$$-\frac{\Delta[\mathrm{R}]}{\Delta t} = k[\mathrm{R}] \qquad \ln\frac{[\mathrm{R}]_t}{[\mathrm{R}]_0} = -kt$$

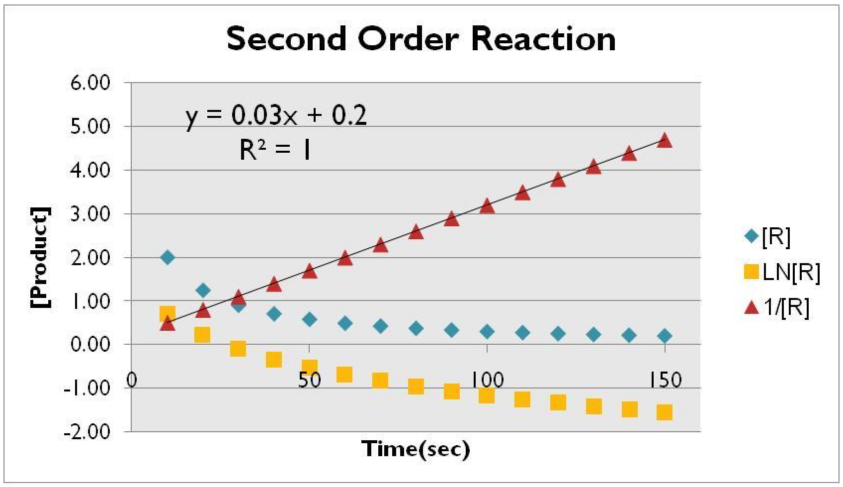


Second-Order Reactions

Suppose the reaction "R $\longrightarrow$ products" is second order.

$$-\frac{\Delta[\mathrm{R}]}{\Delta t} = k[\mathrm{R}]^2$$

$$\frac{1}{[\mathrm{R}]_t} - \frac{1}{[\mathrm{R}]_0} = kt$$



Zero order	First order	Second order
$\underbrace{[\mathrm{R}]_t}_{y} = \underbrace{-kt}_{mx} + \underbrace{[\mathrm{R}]_0}_{b}$	$\underbrace{\ln [\mathrm{R}]_t}_{y} = \underbrace{-kt}_{mx} + \underbrace{\ln [\mathrm{R}]_0}_{b}$	$\underbrace{\frac{1}{[\mathrm{R}]_t}}_{y} = \underbrace{+kt}_{mx} + \underbrace{\frac{1}{[\mathrm{R}]_0}}_{b}$

Examples:

The decomposition of dinitrogen pentoxide is a first order process.

$$2\ N_2O_5(g) \longrightarrow 4\ NO_2(g) + O_2(g)$$

$$\text{rate} = \frac{-\Delta[N_2O_5]}{\Delta t} = k[N_2O_5]$$

$$k = \frac{0.0067}{\text{min}}$$

If the initial concentration of N_2O_5 is 0.70 M, what will the concentration be in 5.6 minutes?

The decomposition of nitrous oxide at 565 ^oC,

$$2\ N_2O \rightarrow 2\ N_2 + O_2$$

is second order in N_2O. If the reaction is initiated with $[N_2O]$ equal to 0.108 M, and drops to 0.0940 M after 1250 s have elapsed, what is the rate constant?