Lecture 4.2 · Reaction Rate Equation

Note Title 1/4/2012

rate$_{rxn}$ · How fast is the reaction going? graph conc. vs time ... slope $\frac{\Delta conc}{\Delta t}$ ... rate

.. depends on concentrations of reactants ...

Consider $\underbrace{A + B + C}_{\text{reactants}} \longrightarrow \underbrace{D + E}_{\text{products}}$

rxn rate equation: $\text{rate}_{rxn} = k[A]^x[B]^y[C]^z$ ← rxn rate const.

Example: $\text{rate}_{rxn} = k[A]^0[B]^1[C]^2$

... rxn is Zeroth order in [A]
. rxn is first order in [B]
... rxn is second order in [C]

... rxn is 0+1+2 = 3 .. 3rd order overall.

• How does doubling (2x) the [A] affect the rxn rate?

rate = $k[A]^0[B]^1[C]^2$

rate = $k(2[A])^0[B]^1[C]^2$

rate = $2^0\, k[A]^0[B]^1[C]^2$

rate = 2^0 × rate

rate = 1 × rate = rate

.. doubling [A] no effect on rxn rate

• How does tripling (3x) the [B] affect the rxn rate?

rate = $k[A]^0[B]^1[C]^2$

rate = $k[A]^0(3[B])^1[C]^2$

rate = $3^1\, k[A]^0[B]^1[C]^2$

rate = 3^1 · rate

rate = 3 · rate.

1st order tripling [B], triples rate

• How does quadrupling (4x) the [C] affect the rxn rate?

rate = $k[A]^0[B]^1[C]^2$

rate = $k[A]^0[B]^1(4\cdot[C])^2$

rate = $4^2 \cdot k[A]^0[B]^1[C]^2$

rate = 16 × rate

2nd rxn 4x conc ⇒ $4^2 = 16$x faster reaction.

• How would all of the above changes to [A], [B] & [C] affect the reaction rate?

2×[A], 3×[B], 4×[C]

rate = $k[A]^0[B]^1[C]^2$

rate = $k(2[A])^0(3\cdot[B])^1\cdot(4\cdot[C])^2$

rate = $2^0 \cdot 3^1 \cdot 4^2\, k[A]^0[B]^1[C]^2$

rate = 1 · 3 · 16 rate

rate = 48 × rate

rxn goes 48x faster