AP Chemistry - Supplementary

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Rate Law

Imagine the following elementary chemical reaction,

$A + 2B \rightarrow 3C + 4D$

From stoichiometry, we can write the rate as folllowing.

$$\text{Rate} = -\frac{\mathrm{d}}{\mathrm{d}t}[A] = -\frac{1}{2}\frac{\mathrm{d}}{\mathrm{d}t}[B] = \frac{1}{3}\frac{\mathrm{d}}{\mathrm{d}t}[C] + \frac{1}{4}\frac{\mathrm{d}}{\mathrm{d}t}[D]$$

Imagine $\frac{\mathrm{d}}{\mathrm{d}t}[A] = 1\frac{M}{s}$, then we can find change of other molecules as following $\frac{\mathrm{d}}{\mathrm{d}t}[B] = 2$, $\frac{\mathrm{d}}{\mathrm{d}t}[C] = 3$, $\frac{\mathrm{d}}{\mathrm{d}t}[D] = 4$

In elementary reactions, the rate can be written by the law of mass action, which states the rate of a chemical reaction is directly proportional to the product of the activities or concentrations of the reactants.

$A + B + B \rightarrow k[A]\{B\}\{B\} = k[A][B]^2$

The rate of elementary chemical reaction is proportional to the concentration of each reactants since products are formed from effective collisions.

If mechanism is not elementary, there may be multiple intermediary steps from reactants to products. Therefore, it is still true that rate would depend on A, B, C, D, but one cannot infer exponents from stoichiometry.

$\text{Rate} = k[A]^{x_1}[B]^{x_2}[C]^{x_3}[D]^{x_4}$.

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3/36.468*58.44
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ans = 4.8075
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syms x
eqn = 4.7*10^3 == x^2/(0.25-x)/(0.6-x)
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eqn =
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$$4700 = \frac{x^2}{\left(-\frac{1}{4}+x\right)\left(-\frac{3}{5}+x\right)}$$

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vpa(solve(eqn))
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ans =
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$$\begin{pmatrix} 0.24996202174268817116737368851529 \\ 0.60021886780828011995839775221678 \end{pmatrix}$$