Lecture 4.3. Determination of the Reaction Rate Equation

Note Title 1/4/2012

Using exp info to determine the rxn. rate equation.

Problem Solving. Change only variable a time.

28. (5 points) Given the following information:

Rxn: $2\,NO(g) + O_2(g) \rightarrow 2\,NO_2(g)$

	reactants $[NO]_i$ (M)	$[O_2]_i$ (M)	Initial Rate (Ms^{-1})
exp1	0.030	0.0055	8.55×10^{-3}
exp2	0.030	0.0110	1.71×10^{-2}
exp3	0.060	0.0055	3.42×10^{-2}
exp4	0.035	0.015	X

exp1 → exp2: $[NO]_i$ ×2, $[O_2]_i$ NC; rate ×2

exp1 → exp3: $[NO]_i$ NC, $[O_2]_i$ ×2; rate ×2

Determine the i) rate law equation, ii) value of k and iii) reaction rate X.

(Explanations and/or work are required for any credit. You decide how much is enough)

i) $\text{rate} = k[NO]^x[O_2]^y$

x: $[NO]$ changes ×2, $[O_2]$ const NC

$\frac{3.42\times10^{-2}}{8.55\times10^{-3}} = 4$

rxn rate increase ×4

$2^x = 4$

$x = 2$

∴ rxn 2nd order $[NO]$

$\text{rate} = k[NO]^2[O_2]^y$

y: $[NO]$ const NC

$[O_2]$ changes 2x

reaction rate 2x

$2^y = 2$

$y = 1$

1st order in $[O_2]$

i) $\text{rate} = k[NO]^2[O_2]^1 = k[NO]^2[O_2]$

ii) calc value for k (include the units)

$\text{rate} = \overset{?}{k}[NO]^2[O_2]$

Exp.#3

$k = \frac{\text{rate}}{[NO]^2[O_2]}$

Exp#3 $k = \frac{3.42\times10^{-2}\ \frac{M}{s}}{(0.060\,M)^2(0.0055\,M)} = 1727.27\ \frac{\frac{M}{s}}{M^2 \cdot M}$

$= \underset{2\,S.F.}{1700}\ \frac{M}{s}\cdot\frac{1}{M^3}\left(\frac{1}{sM^2}\right)$

$k = 1700\ \frac{1}{sM^2}$

iii) reaction rate X (exp#4)

$[NO]_i = 0.035M$ $[O_2]_i = 0.015M$

$\text{rate} = k[NO]^2[O_2]$

$\text{rate} = (1727.27)(0.035M)^2(0.015M)$

$\text{rate} = 0.03173\ M/s = 0.032\ M/s$