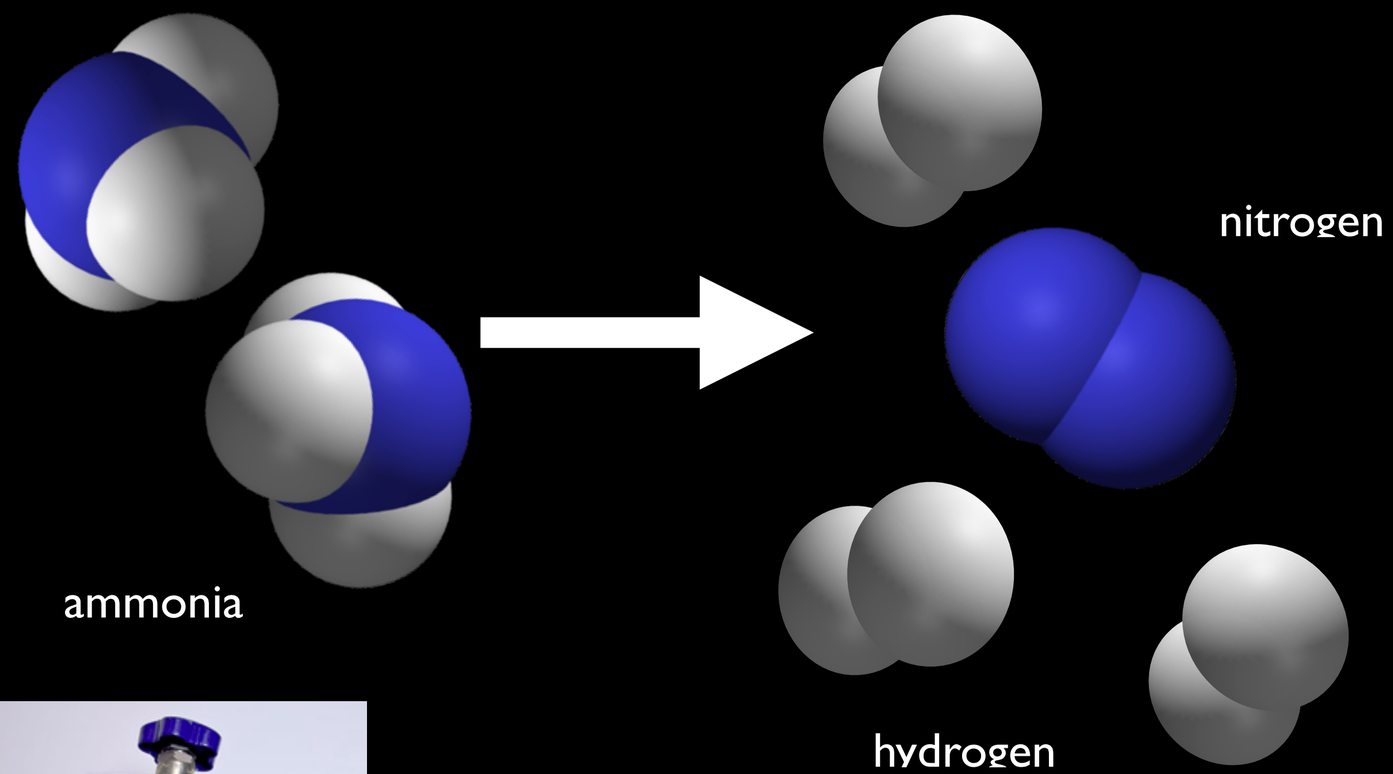
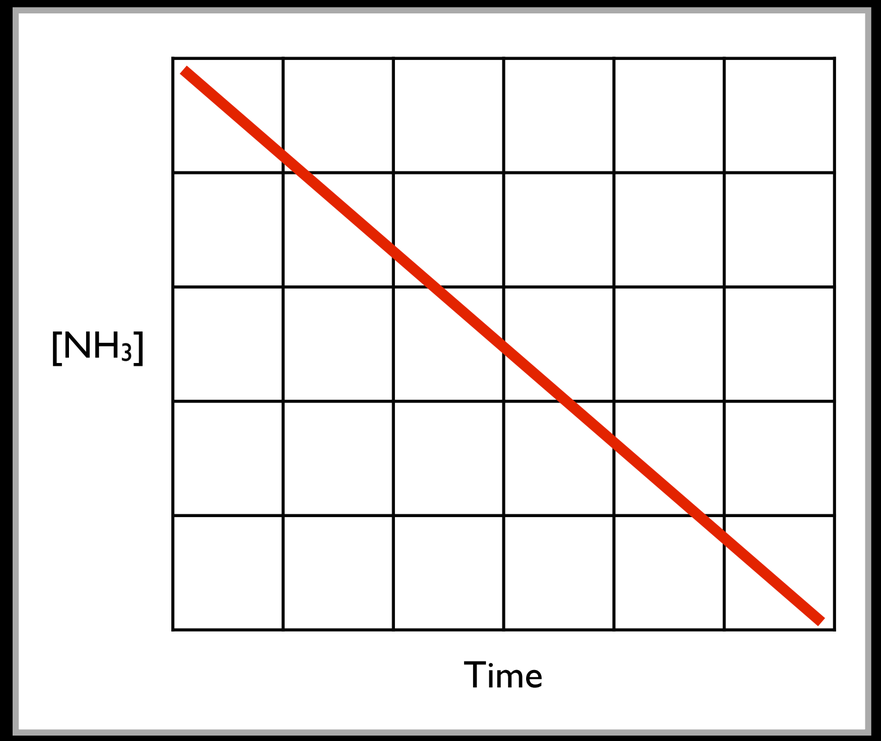
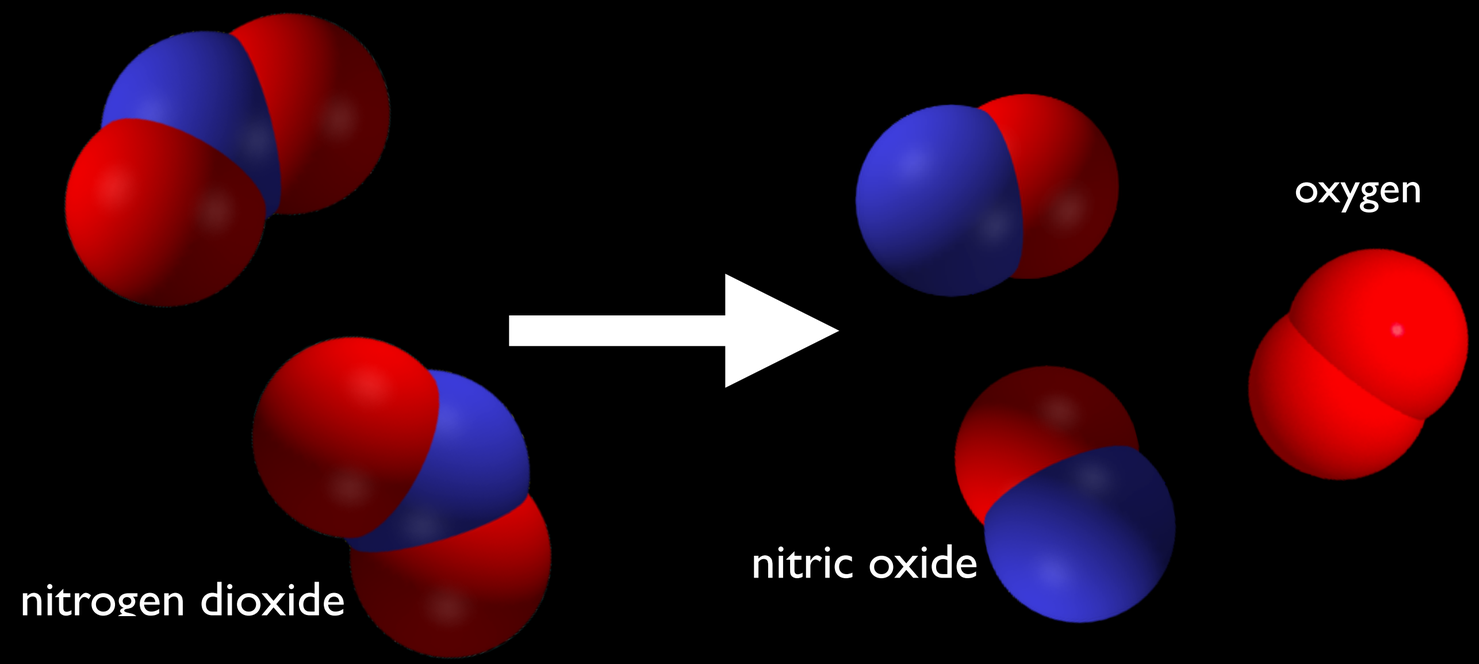
The Rate Law

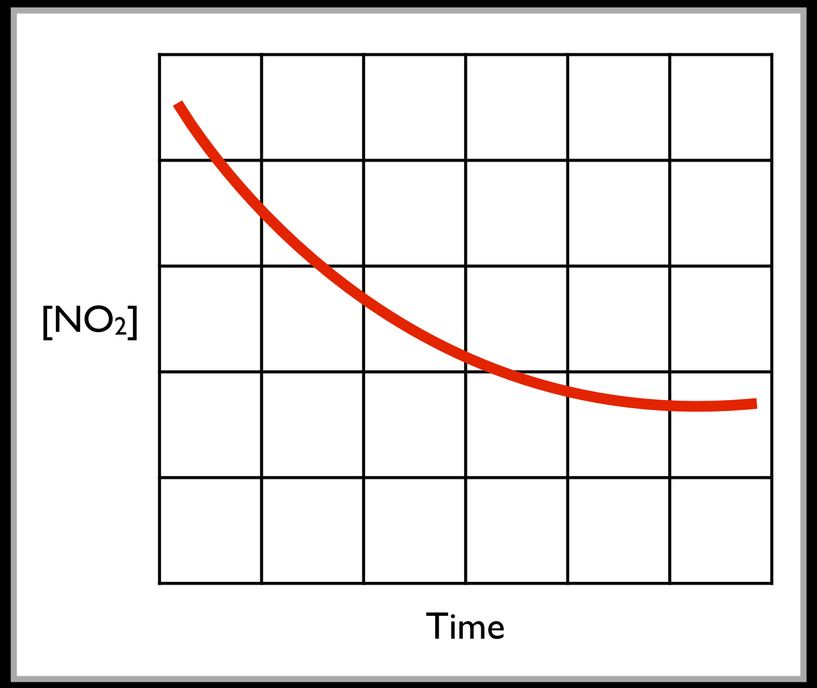




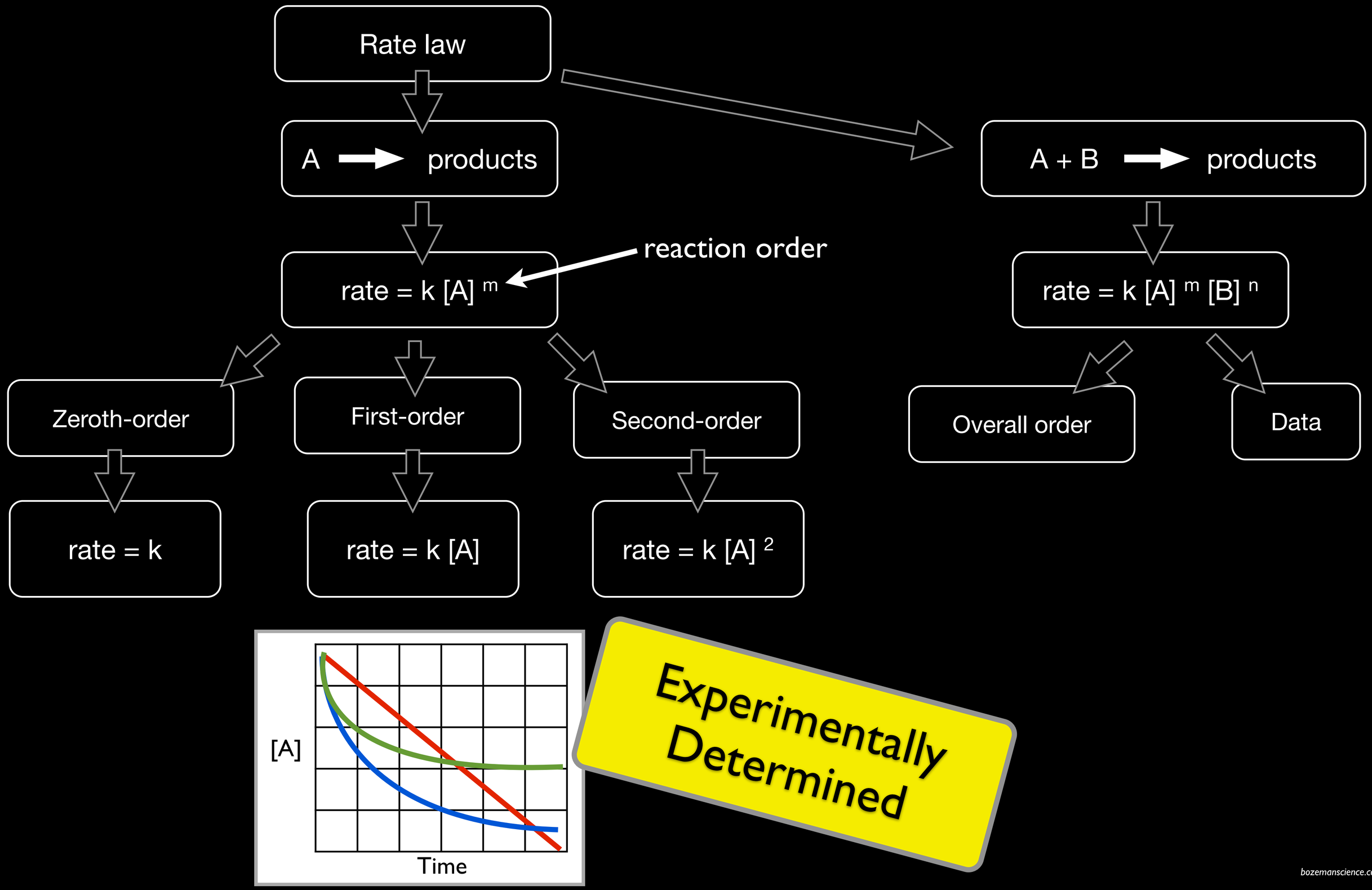
Chemistry Essentials - 036

The Rate Law





Chemistry Essentials - 036


Rate law
A → products
rate = k [A] m
reaction order
Zeroth-order
First-order
Second-order
rate = k
rate = k [A]
rate = k [A] 2
A + B → products
rate = k [A] m [B] n
Overall order
Data
[A]
Time
Experimentally Determined
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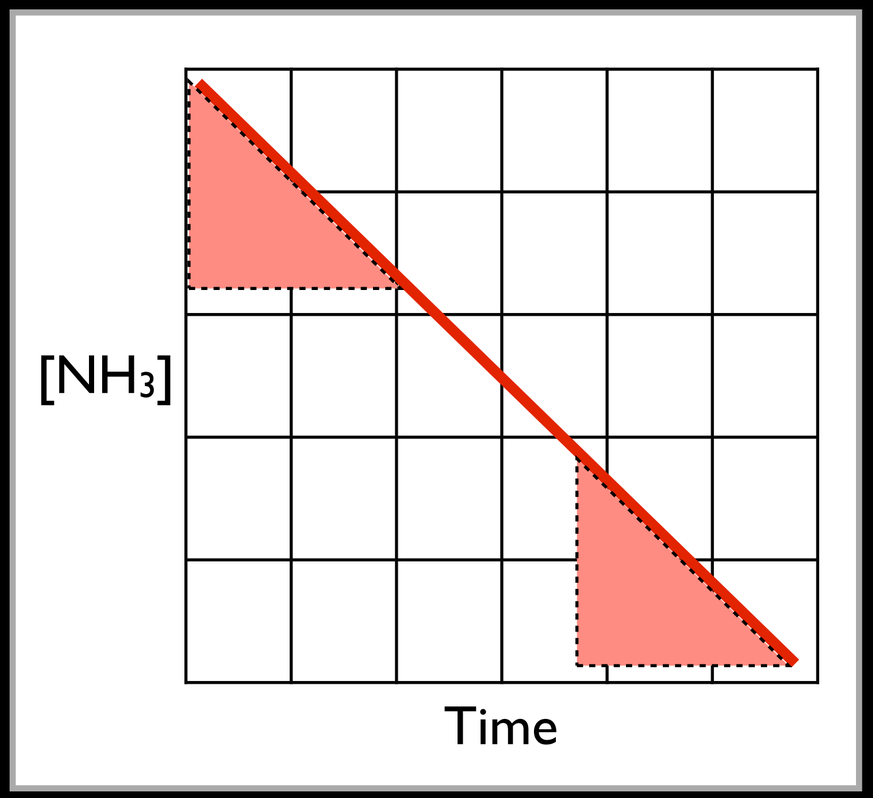
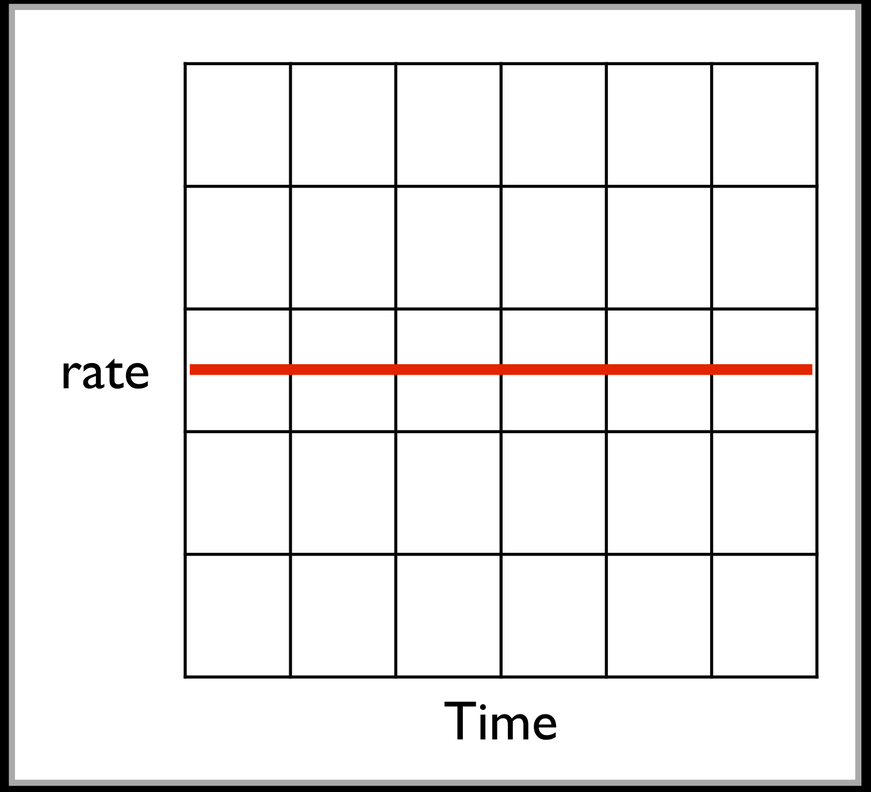
Zeroth Order Reaction

$$2NH_3\ (g) \longrightarrow 3H_2\ (g) + N_2\ (g)$$

rate = k



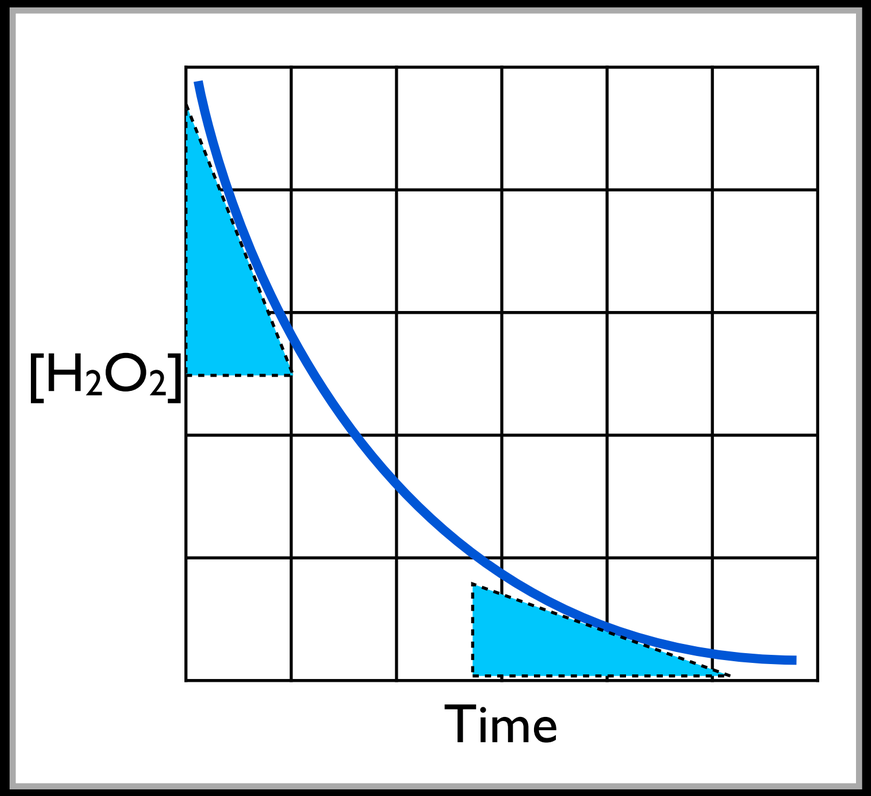
Experiment	[A] (M)	rate (M/s)
1	0.4	2.0×10^{-3}
2	0.2	2.0×10^{-3}
3	0.1	2.0×10^{-3}



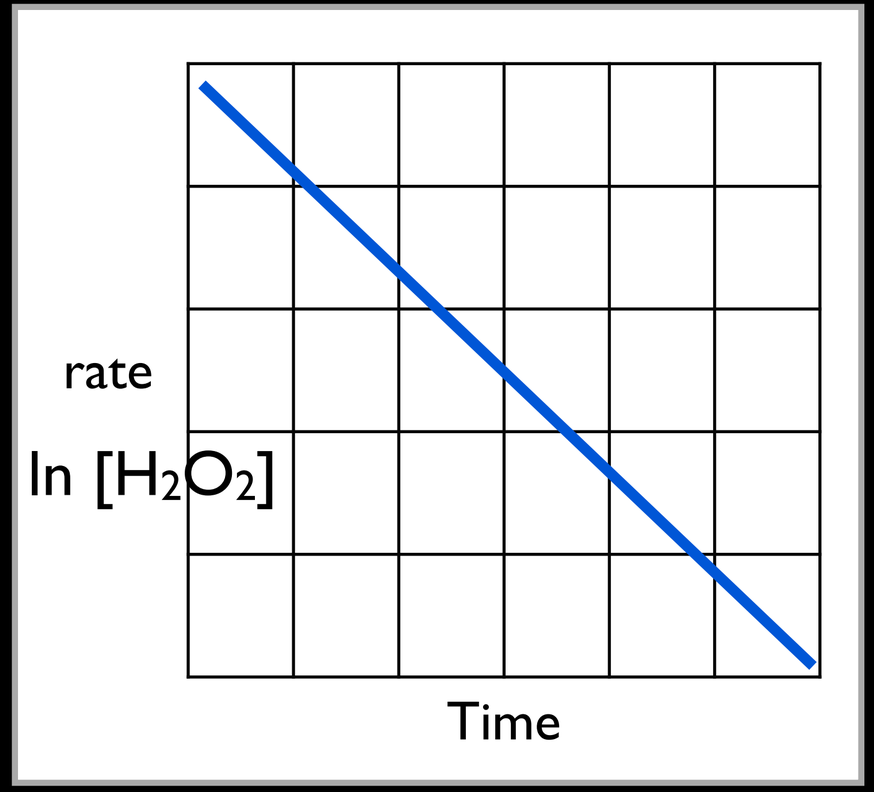
First Order Reaction

$$H_2O_2\ (l) \longrightarrow H_2O\ (l) + 1/2O_2\ (g)$$

rate = k [A]



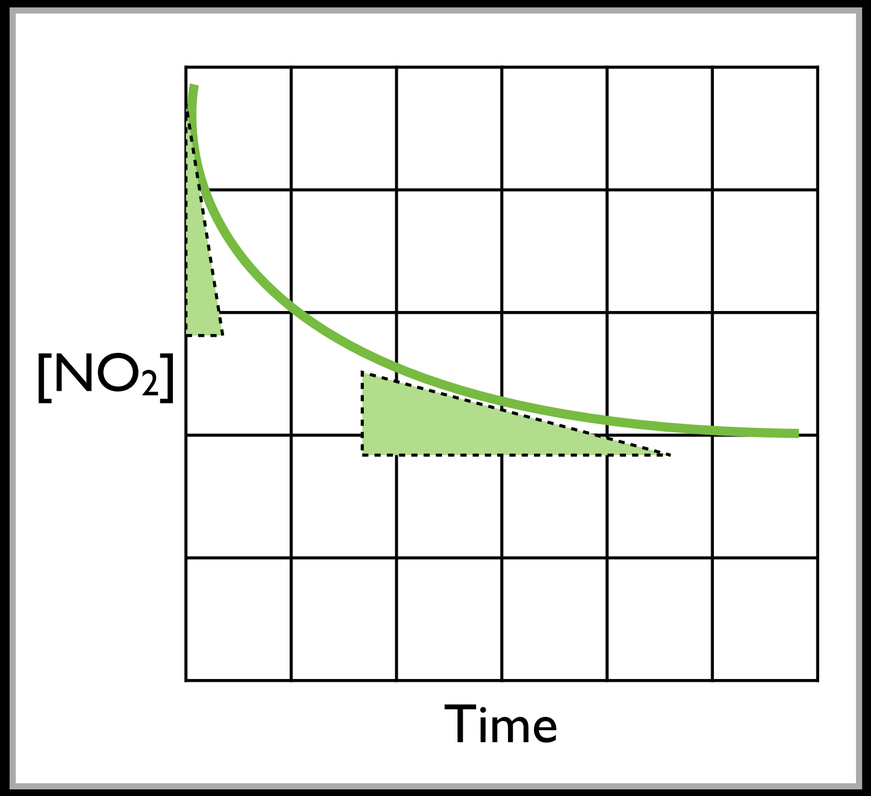
Experiment	[A] (M)	rate (M/s)
1	0.4	8.0×10^{-3}
2	0.2	4.0×10^{-3}
3	0.1	2.0×10^{-3}



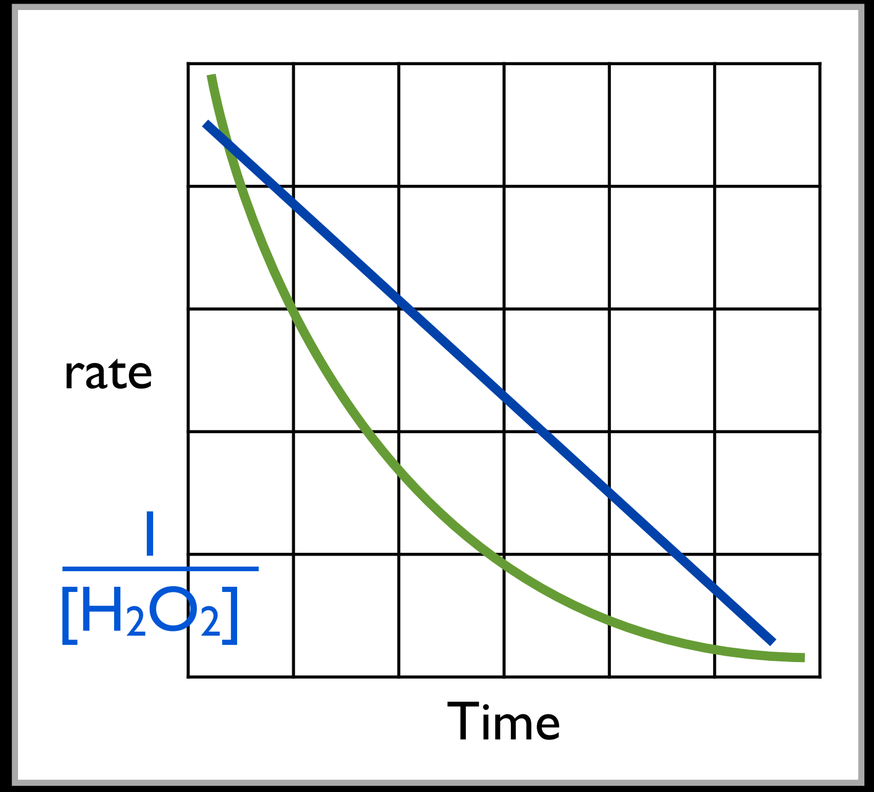
Second Order Reaction

$$2NO_2\ (g) \longrightarrow 2NO\ (g) + O_2\ (g)$$

$$\text{rate} = k\,[A]^2$$



Experiment	[A] (M)	rate (M/s)
1	0.4	16.0×10^{-3}
2	0.2	4.0×10^{-3}
3	0.1	2.0×10^{-3}



Overall Reaction Order

$$A + B \longrightarrow \text{Products}$$

Experiment	[A] (M)	[B] (M)	Rate (M/s)
1	0.1	0.1	3.0×10^{-3}
2	0.1	0.2	3.0×10^{-3}
3	0.2	0.1	9.0×10^{-3}

$$\text{rate} = k\,[A]^2\,[B]^0 = k\,[A]^2$$

Overall Reaction Order

$$A + B \longrightarrow \text{Products}$$

Experiment	[A] (M)	[B] (M)	Rate (M/s)
1	0.1	0.1	3.0×10^{-3}
2	0.1	0.2	6.0×10^{-3}
3	0.2	0.1	6.0×10^{-3}

rate = ?

A $\longrightarrow$ Products

Time (s)	[A] (M)	[A] vs. t	ln [A] vs. t	1/[A] vs. t
0	0.0032			
10	0.00251			
20	0.00208			
40	0.00154			
60	0.00122			

Graphs

Zero	Absorbance vs. Time
First	In Absorbance vs. Time
Second	1 / Absorbance vs. Time

Spectrophotometer

$$CV^+ + OH^- \longrightarrow CVOH$$

Did you learn?

$$A \longrightarrow \text{Products}$$

Time (s)	[A] (M)	[A] vs. t	ln [A] vs. t	1/[A] vs. t
0	0.00320			
10	0.00251			
20	0.00208			
40	0.00154			
60	0.00122			

To analyze concentration vs. time data to determine the rate law for *zeroth*-, *first*-, and *second*-order reaction.

Acknowledgements

"File:Ammonia-3D-vdW.png," October 19, 2013. http://en.wikipedia.org/wiki/File:Ammonia-3D-vdW.png.

File:Crystal Violet in Aqueous Solution.jpg, n.d. http://en.wikipedia.org/wiki/File:Crystal_Violet_in_aqueous_solution.jpg.

"File:Nitric-Oxide-3D-vdW.png," October 19, 2013. http://en.wikipedia.org/wiki/File:Nitric-oxide-3D-vdW.png.

"File:Nitrogen Dioxide at Different Temperatures.jpg," October 19, 2013. http://en.wikipedia.org/wiki/File:Nitrogen_dioxide_at_different_temperatures.jpg.

"File:Nitrogen-Dioxide-3D-vdW.png," October 19, 2013. http://en.wikipedia.org/wiki/File:Nitrogen-dioxide-3D-vdW.png.

"File:Oxygen Molecule.png," October 19, 2013. http://en.wikipedia.org/wiki/File:Oxygen_molecule.png.

File:Spektrofotometri.jpg, n.d. http://en.wikipedia.org/wiki/File:Spektrofotometri.jpg.

Izmaelt. *Slovenčina: Príprava Oxidu Dusičitého Z Medi a Kyseliny Dusičnej. Fotené Na Slovenskej Technickej Univerzite.*, October 27, 2010. Own work. *http://commons.wikimedia.org/wiki/File:Nitrogen_dioxide.jpg*.

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