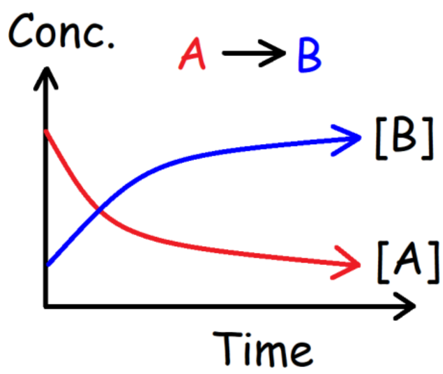
Chemical Kinetics:



Instantaneous Rate of Appearance:

$$Rate = +\frac{d[B]}{dt}$$

Average Rate of Appearance: $A \rightarrow B$

$$Rate = +\frac{\Delta[B]}{\Delta t} = \frac{[B]_F - [B]_0}{t_F - t_0}$$

Average Rate of Disappearance:

$$Rate = -\frac{\Delta[A]}{\Delta t}$$

Rate of a Chemical Reaction:

$$2A + 3B \rightarrow 4C + 5D$$

$$Rate = -\frac{1}{2}\frac{\Delta[A]}{\Delta t} = -\frac{1}{3}\frac{\Delta[B]}{\Delta t} = +\frac{1}{4}\frac{\Delta[C]}{\Delta t} = +\frac{1}{5}\frac{\Delta[D]}{\Delta t}$$

Method of Initial Rates:

Trial	[A]	[B]	[C]	I. Rate
1	0.10 M	0.10 M	0.10 M	0.20 M/s
2	0.20 M	0.10 M	0.10 M	0.40 M/s
3	0.10 M	0.20 M	0.10 M	0.80 M/s
4	0.10 M	0.10 M	0.20 M	0.20 M/s

Rate Constant k:

$$k = \frac{Rate}{[A]^x[B]^y[C]^z}$$

Units of k: $M^{1-n}\, t^{-1}$ ***or*** $(mol)^{1-n}(L)^{n-1}t^{-1}$

Note: $M = mol * L^{-1}$ and $t \rightarrow s, min, hr, days$

Differential Rate Law Expression:

$$Rate = k[A]^x[B]^y[C]^z$$

Finding The Order of a Reactant:

$$x = \frac{\log\left(\frac{Rate\ 2}{Rate\ 1}\right)}{\log\left(\frac{[A]_2}{[A]_1}\right)} \qquad y = \frac{\log\left(\frac{Rate\ 3}{Rate\ 1}\right)}{\log\left(\frac{[B]_3}{[B]_1}\right)}$$

Overall order of the reaction:

$$Order = x + y + z$$

Unimolecular:

$A \rightarrow B$ $\qquad Rate = k[A]$

Bimolecular:

$A + A \rightarrow B$ $\qquad Rate = k[A]^2$

$A + B \rightarrow C$ $\qquad Rate = k[A][B]$

Termolecular:

$A + B + C \rightarrow D$ $\qquad Rate = k[A][B][C]$

$2A + B \rightarrow C$ $\qquad Rate = k[A]^2[B]$

$3A \rightarrow B$ $\qquad Rate = k[A]^3$

Factors Affecting the Rate of a Reaction:

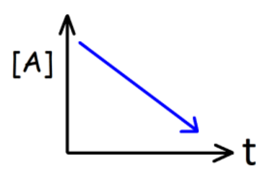
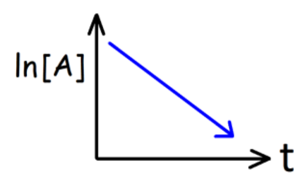
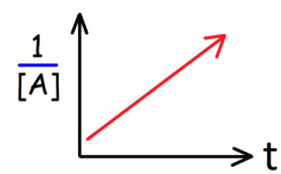
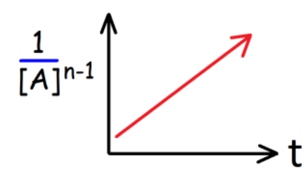
1. Temperature
2. Concentration
3. Catalyst
4. Surface Area
5. The Nature of the Reactants

Reaction Mechanisms:

$A + B \rightarrow C + D \qquad Rate = k_1[A][B]$

$D + E \rightarrow F + B \qquad Rate = k_2[D][E]$

Note: $Catalyst \rightarrow B \qquad Intermediate \rightarrow D$

Reaction Order:	Zero Order:	1st Order:	2nd Order:	Nth Order: $(n \neq 1)$
Differential Rate Law Expression:	$Rate = k$	$Rate = k[A]^1$	$Rate = k[A]^2$	$Rate = k[A]^n$
Units of k: $(M = mol^1L^{-1})$ $t \rightarrow time\ (s, min, hr, days)$	M^1t^{-1}	t^{-1}	$M^{-1}t^{-1}$	$M^{1-n}t^{-1}$
Half-Life:	$t_{1/2} = \frac{[A]_0}{2k}$	$t_{1/2} = \frac{\ln 2}{k}$	$t_{1/2} = \frac{1}{k[A]_0}$	$t_{1/2} = \frac{1}{k(n-1)} \cdot \frac{2^{n-1}-1}{{[A]_0}^{n-1}}$
Integrated Rate Law:	$[A]_F = -kt + [A]_0$	$\ln[A]_F = -kt + \ln[A]_0$	$\frac{1}{[A]_F} = +kt + \frac{1}{[A]_0}$	$\frac{1}{{[A]_F}^{n-1}} = kt(n-1) + \frac{1}{{[A]_0}^{n-1}}$
Slope:	$m = -k$	$m = -k$	$m = +k$	$m = k(n-1)$
Straight-line Plot:	$[A]\ vs\ t$	$\ln[A]\ \ vs\ t$	$\frac{1}{[A]}\ vs\ t$	$\frac{1}{[A]^{n-1}}\ vs\ t$
Graph:		 IRL Formula Variation: $[A]_F = [A]_0e^{-kt}$ $\ln\left(\frac{[A]_F}{[A]_0}\right) = -kt$		 **Note:** $n \geq 2$

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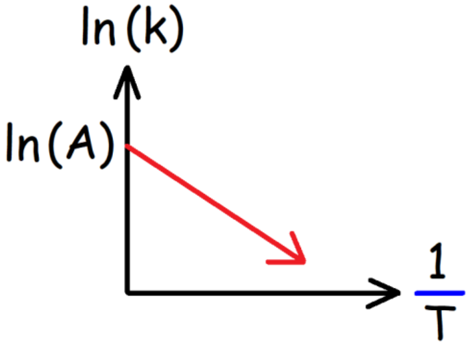


Arrhenius Equation – Slope Intercept Form:

$$\ln(k) = -\frac{E_a}{R}\left(\frac{1}{T}\right) + \ln(A)$$

$$y = mx + b$$

Slope (m) and Y-Intercept (b):

$$m = -\frac{E_a}{R} \qquad b = \ln(A)$$

The Activation Energy: (J/mol)

$$E_a = -\left[\frac{R\ln\left(\frac{k_2}{k_1}\right)}{\left[\frac{1}{T_2}-\frac{1}{T_1}\right]}\right] \qquad E_a = -R \cdot Slope$$

Arrhenius Equation – Standard Form:

$$\ln\left[\frac{k_2}{k_1}\right] = -\frac{E_a}{R}\left[\frac{1}{T_2}-\frac{1}{T_1}\right]$$

$$R = 8.3145\ J/(mol * K)$$

Temperature – Arrhenius Equation:

$$T_2 = \left[\frac{1}{T_1} - \frac{R\ln\left(\frac{k_2}{k_1}\right)}{E_a}\right]^{-1}$$

Arrhenius Equation – The Rate Constant k:

$$k_2 = k_1\, e^{-\frac{E_a}{R}\left[\frac{1}{T_2}-\frac{1}{T_1}\right]}$$

Notes:

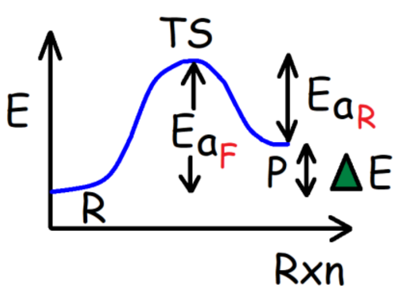
$A \rightarrow Frequency\ Factor$
$z \rightarrow Collision\ Frequency$
$p \rightarrow Collision\ Orientiation\ (Steric\ Factor)$
$e^{-E_a/RT} \rightarrow Collsion\ Energy$
$b \rightarrow Y - intercept$

The Rate Constant k:

$$k = Ae^{-E_a/RT}$$

Frequency Factor (A):

$$A = zp \qquad A = e^b \qquad 0 < p < 1$$



$$\Delta E = Ea_F - Ea_R$$

Rate Constant (k) and Activation Energy (Ea):

$$k_2 = k_1 e^{-(Ea_2 - Ea_1)/RT}$$

$$Ea_2 = Ea_1 - RT\ln\left(\frac{k_2}{k_1}\right)$$

Rate Constant (k) vs Time (t):

$$\frac{k_2}{k_1} = \frac{t_1}{t_2}$$