IAL Chem Unit 4 Kinetics Cheat Sheet

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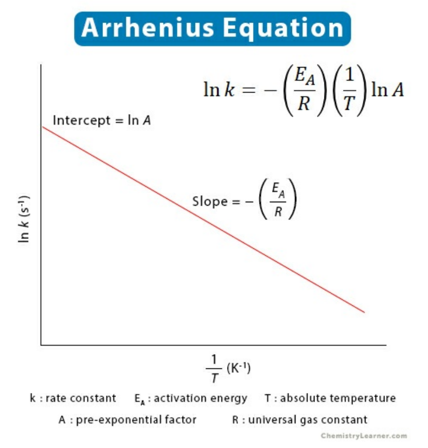
Key Definitions

Term	Definition
Rate of Reaction	Change in concentration of a reactant or product per unit time.
Rate Equation	Rate = $k\,[A]^m\,[B]^n$ where m, n are the orders of the reaction.
Order of Reaction	The power to which the concentration of a reactant is raised in the rate law
Overall Order	The sum of the powers (orders) of all reactants in the rate equation. Order = m+n.
Half-life ($t_{1/2}$)	Time taken for the concentration of a reactant to fall to half its value.
Rate Constant (k)	Proportionality constant in the rate equation; depends on temperature.
Activation Energy (E_a)	Minimum energy needed for a reaction to occur.
Adsorption	The binding of molecules to a surface (such as a catalyst), which increases reaction rate.
Desorption	The release of products from a catalyst surface after the reaction.

Arrhenius Equation



$k=Ae^{E_a/RT}$

Where

k = Chemical Reaction Rate

A = Pre-exponential factor

E_a = Activation Energy

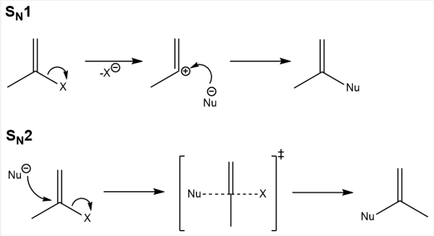
R = Gas Constant

T = Temperature in Kelvin

Mechanisms: SN1 vs SN2

Feature	SN1	SN2
Steps	2 steps (carbocation formed)	1 step (simultaneous attack/leave)
Reactivity	Tertiary haloalkanes	Primary haloalkanes
Rate Law	rate = k[haloalkane]	rate = k[haloalkane]$[Nu^-]$
Steric Hindrance	Low (carbocation intermediate)	High (due to nucleophile approach)

SN1 & SN2



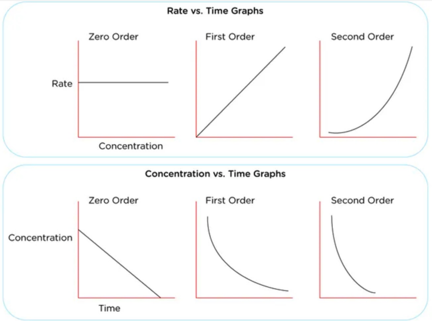
Experimental Techniques

Method	Measurement	Used For
Mass loss	Decreasing mass (gas released)	Rate of gas-producing reactions
Volume of gas	Gas syringe / upside-down cylinder	Gas evolution
Titration	Concentration vs time	Accurate kinetic data
Colorimetry	Absorbance vs concentration	Colored species (e.g. I_2 reaction)

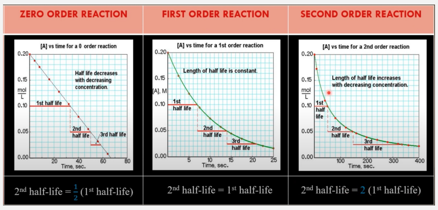
Rate Laws & Integrated Rate Equations

Order	Rate Law	Half-life
Zero	rate = k	$t_{1/2} = [A]_0 / 2k$
First	rate = k[A]	$t_{1/2} = \ln 2 / k$
Second	rate = $k[A]^2$	$t_{1/2} = 1 / (k[A]_0)$

Graphs



Half Life



Rate Determining Step (RDS)

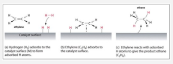
1. The slowest step in a mechanism controls the overall rate.
2. Only species involved up to RDS appear in the rate equation.
3. Powers in rate law = number of molecules in RDS.

Catalysis

Type	Phase	Example	Notes
Homogeneous	Same as reactants	Fe^{2+}/Fe^{3+} in $S_2O_8^{2-} + I^-$	Catalyst regenerated via redox steps
Heterogeneous	Different from reactants	Fe in Haber process	Provides surface, weakens bonds, speeds reaction

Catalysts lower the activation energy of a reaction by providing an alternate reaction route.

Adsorption (in Heterogeneous Catalysis)



Adsorption is when reactant molecules bind to active sites on the surface of a solid catalyst.

This:
1. Brings molecules close together, increasing collision frequency
2. Weakens bonds in the reactants, lowering activation energy
3. Allows for a faster reaction

After the reaction, products desorb (leave) from the surface, freeing the site for reuse.