Reaction Mechanisms

Based on the idea that reactions follow a path of multiple steps, you need to be able to derive a rate expression from a reaction mechanism.

3 Basic Rules

1. The slow step is always rate determining.
2. For any step in the reaction mechanism you can just use its stoichiometric coefficient as its rate-order.
3. The final rate expression must include only species that are in the overall reaction. <-- use equilibrium expressions from fast steps to get rid of reaction intermediates.

For example:

The overall reaction is $2\ NO_{(g)} + Cl_{2(g)} \text{ <=====> } 2\ NOCl_{(g)}$

The rate law is found to be second order in $NO_{(g)}$ and first order in $Cl_{2(g)}$. Derive this expression from the proposed reaction mechanism:

1.	$NO_{(g)} + Cl_{2(g)} \text{ <=====> } NOCl_{2(g)}$	fast
2.	$NOCl_{2(s)} + NO_{(g)} \text{ <=====> } 2\ NOCl_{(g)}$	slow

1. Slow step is rate determining: $r = k[NOCl_2][NO]$
2. NOCl is a reaction intermediate so use an equilibrium constant expression to get rid of it.

$$K_C = \frac{[NOCl_2]}{[NO][Cl_2]} \qquad [NOCl_2] = K_C[NO][Cl_2]$$

3. Plug in: $r = kK_C[NO][Cl_2][NO]$

$r = kK_C[NO]^2[Cl_2]$

So your final rate law is: $\mathbf{r = k'[NO]^2[Cl_2]}$