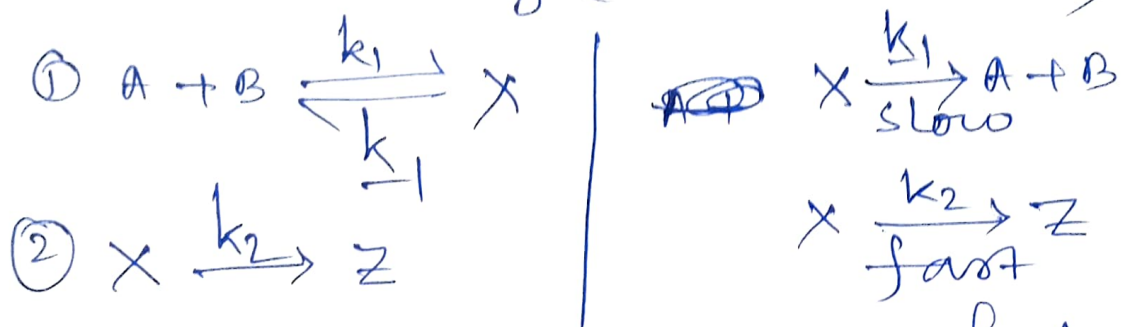


Rate-Determining (Rate-Controlling) Steps



~~If we assume~~ The rate of formation of X from $A + B$ (other steps are assumed to be absent) is

Case I: $v_X = k_1 [A][B] \quad \text{--- (A)}$

Assume $k_2 \gg k_{-1}$ that means that the intermediate is converted very rapidly into Z , much more rapidly than it can go back into $A + B$.

Then the ~~the~~ formation of Z will be reduced into

$$v = v_Z = \frac{d[Z]}{dt} = \frac{k_1 k_2 [A][B]}{k_{-1} + k_2}$$

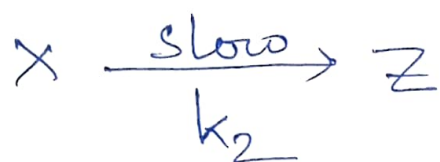
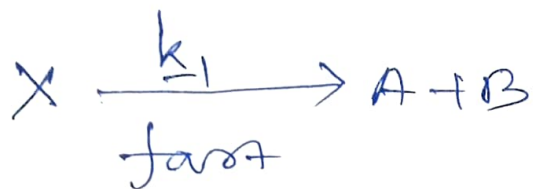
$$= k_1 [A][B]$$

comes from steady state approximation

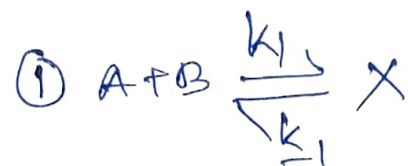
$$= v_X \rightarrow (\text{from Eq. (A)})$$

Then the initial step ($A + B \xrightarrow{k_1} X$) is the rate determining step.

Case II



$$k_2 \ll k_1$$



$$\begin{aligned} v = v_2 &= \frac{d[Z]}{dt} = \frac{k_1 k_2}{k_{-1} + k_2} [A][B] \\ &= \frac{k_1 k_2}{k_{-1}} [A][B] \end{aligned}$$

~~Now~~ Reaction $\textcircled{2} X \xrightarrow{k_2} Z$ is now the rate-determining step or the rate-controlling step.
