Quiz 14.4 – Reaction Mechanisms and Catalysis

Name: Key

Question 1

Consider the decomposition of ozone: $2\,O_3(g) \longrightarrow 3\,O_2(g)$ $\quad \Delta H_{rxn} = -185.4\,\frac{kJ}{mol}$

With the following proposed mechanism:

$O_3(g) \rightleftharpoons O_2(g) + O(g)$ FAST

$O(g) + O_3(g) \longrightarrow 2\,O_2(g)$ SLOW

$O_3 + \emptyset + O_3 \rightarrow O_2 + \emptyset + 2O_2$

$2O_3 \rightarrow 3O_2$

- Does this mechanism add up to the total overall reaction? Yes
- Identify any catalysts or intermediates in this mechansm: Catalyst: NONE intermediate: O(g)
- Give the molecularity and the rate law for each elementary step (including the reverse reaction in step 1):
- Give the predicted overall rate law for this mechanism: $\text{rate} = k_2[O][O_3] \rightarrow \text{rate} = \frac{k_2 k_1}{k_{-1}}\frac{[O_3]^2}{[O_2]}$
- Draw a plausible reaction coordinate diagram for this reaction

Step 1: Unimolecular : $\text{rate}_1 = k_1[O_3]$

reverse Step 1: bimolecular : $\text{rate}_{-1} = k_{-1}[O_2][O]$

Step 2: bimolecular : $\text{rate}_2 = k_2[O][O_3]$

$\text{rate}_1 = \text{rate}_{-1}$ $\quad k_1[O_3] = k_{-1}[O_2][O] \rightarrow [O] = \frac{k_1}{k_{-1}}\frac{[O_3]}{[O_2]}$

Question 2

Enzymes are biomolecules which catalyze the reaction of a substrate to form products: S $\longrightarrow$ P

Enzymes often follow the *Michaelis-Menton* reaction mechanism:

$E + S \rightleftharpoons ES$ FAST

$ES \longrightarrow E + P$ SLOW

$ES + E + S \rightarrow ES + E + P$

$S \rightarrow P$ Yes

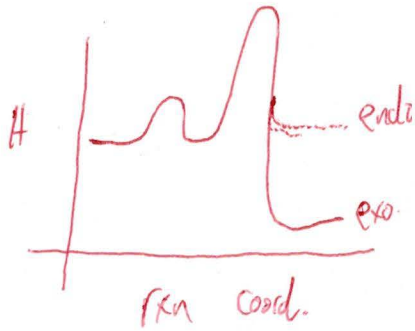
Catalyst: E intermediate: ES

Answer the same questions above for the Michaelis-Menton mechanism

Step 1: bimolecular : $\text{rate}_1 = k_1[E][S]$

reverse step 1: unimolecular : $\text{rate}_{-1} = k_{-1}[ES]$

Step 2: unimolecular : $\text{rate} = k_2[ES]$



$\text{rate}_1 = \text{rate}_{-1} \rightarrow k_1[E][S] = k_{-1}[ES] \rightarrow [ES] = \frac{k_1}{k_{-1}}[E][S]$

$\text{rate} = k_2[ES]$ $\quad \text{rate} = \frac{k_2 k_1}{k_{-1}}[E][S]$