

$$k_1 [E][S] = k_{-1} [ES] + k_2 [ES]$$

letting $[E] = [E]_T - [ES]$ and rearranging

$$\frac{([E]_T - [ES])[S]}{[ES]} = \frac{k_{-1} + k_2}{k_1}$$

the michaelis constant K_M is $K_M = \frac{k_{-1} + k_2}{k_1}$

$$K_M [ES] = ([E]_T - [ES])[S]$$

$$[ES] = \frac{[E]_T [S]}{K_M + [S]}$$

$$v_0 = \left(\frac{d[P]}{dt} \right)_{t=0} = k_2 [ES] = \frac{k_2 [E]_T [S]}{K_M + [S]}$$

$$V_{\max} = k_2 [E]_T$$

$$v_0 = \frac{V_{\max} [S]}{K_M + [S]}$$