Attemptation for 8.3

$$E + S \underset{k_2}{\overset{k_1}{\rightleftharpoons}} ES \xrightarrow{k_3} E + P$$

$$ES \begin{cases} \text{generation rate}: \; v_1 = k_1([E_0] - [ES])[S] \\ \text{decomposition rate}: \; v_2 = (k_2 + k_3)[ES] \end{cases}$$

(E_0: the inital concentration of E)

when balanced state: $v_1 = v_2 \Rightarrow \dfrac{[E_0][S] - [ES][S]}{[ES]} = \dfrac{k_2 + k_3}{k_1}$

make $\dfrac{k_2 + k_3}{k_1} = k_m \Rightarrow k_m[ES] + [ES][S] = [E_0][S] \Rightarrow [ES] = \dfrac{[E_0][S]}{k_m + [S]}$ (1)

the velocity of the enzymatic reaction $v = k_3[ES] \Rightarrow [ES] = \dfrac{v}{k_3}$ (2)

combine (1) and (2): $\dfrac{v}{k_3} = \dfrac{[E_0][S]}{k_m + [S]} \Rightarrow v = \dfrac{k_3[E_0][S]}{k_m + [S]}$

at large concentration of S, $[E_0] = [ES]$, $v = V_m = k_3[E_0]$

the velocity v as a function of the concentration of the substrate S, $v = \dfrac{V_m[S]}{k_m + [S]}$

$\left(V_m = k_3[E_0],\; k_m = \dfrac{k_2 + k_3}{k_1} \right)$