Q2

1. According to the law of mass action:

$$\frac{d[S]}{dt} = k_2[ES] - k_1[E][S]$$

$$\frac{d[E]}{dt} = (k_2+k_3)[ES] - k_1[E][S]$$

$$\frac{d[ES]}{dt} = k_1[E][S] - (k_2+k_3)[ES]$$

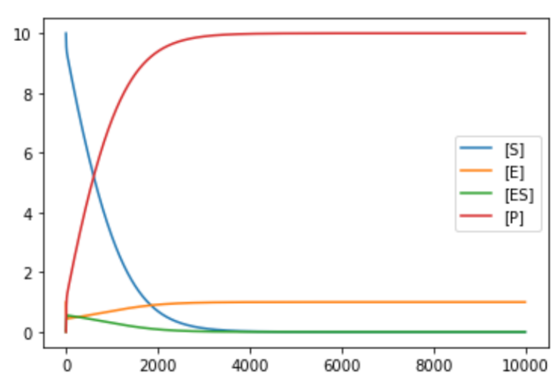
$$\frac{d[P]}{dt} = k_3[ES]$$

2. To solve those four equations, we just need to solve following ODEs.

$$\begin{cases} C_S' = -k_1 C_E C_S + k_2 C_{ES} \\ C_E' = -k_1 C_E C_S + k_2 C_{ES} + k_3 C_{ES} \\ C_{ES}' = k_1 C_E C_S - k_2 C_{ES} - k_3 C_{ES} \end{cases} \quad \text{where} \quad \begin{cases} C_{E_0} = 1 \\ C_{S_0} = 10 \\ C_{ES_0} = 0 \end{cases} \quad \text{and} \quad \begin{cases} k_1 = 100 \\ k_2 = 600 \\ k_3 = 150 \end{cases}$$

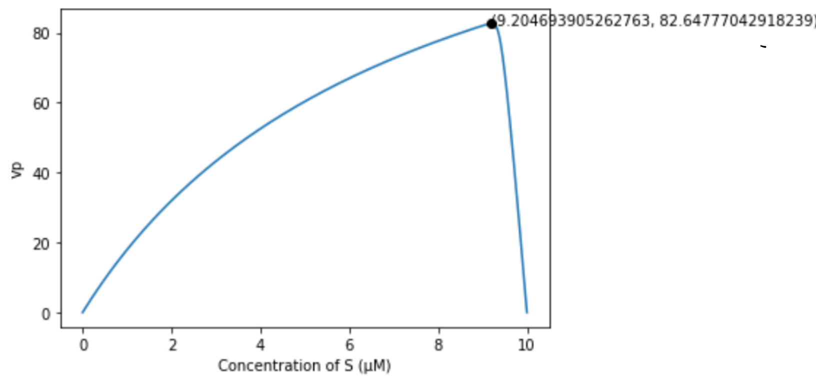
And C_{P_n} can be estimated by $C_{P_{n-1}} + \Delta C_{ES} - \Delta C_S$, where ΔC_{ES} and ΔC_S is the change of C_E and C_S during the interval.

Then use Runge kutta-4 to solve equations:



3. $V_p = \frac{d[P]}{dt} = k_3 \cdot [ES]$

Plot the graph where x-axis is S, and y-axis is V_p.



It can be seen ~~that~~ when C_s is high

V_p reaches highest value about 82.6 um/min.