Question 2 Answers

8.1

S:

1. Decomposition rate for E+S -> ES: $k_1[E][S]$
2. Formation rate for ES -> E+S: $k_2[ES]$

Rate of change for S: $\frac{d[S]}{dt} = -k_1[E][S] + k_2[ES]$

E:

1. Decomposition rate for E+S -> ES: $k_1[E][S]$
2. Formation rate for ES -> E+S: $k_2[ES]$
3. Formation rate for ES -> E+P: $k_3[ES]$

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

ES:

1. Formation rate for E+S -> ES: $k_1[E][S]$
2. Decomposition rate for ES -> E+S: $k_2[ES]$
3. Decomposition rate for ES -> E+P: $k_3[ES]$

Rate of change for ES: $\frac{d[ES]}{dt} = k_1[E][S] - k_2[ES] - K_3[ES] = k_1[E][S] - (k_2 + k_3)[ES]$

P:

1. Formation rate for ES -> E+P: $k_3[ES]$

Rate of change for P: $\frac{d[P]}{dt} = k_3[ES]$

8.2

I used the 4th order Runge-Kutta method to solve the equations above. The step size I used is 0.001. Code written in Python can be found in q2.py and the results are saved in Results.csv. *Figure 1* below shows the concentration change of all 4 species. It is clear that the concentration of S drops gradually while that of P increases. For E, it drops at first but begin to rise after sometime, similar to the change of ES (but in a opposite direction). This is due to the decomposition of ES -> E + P. This plot is saved as concentration_change.png.

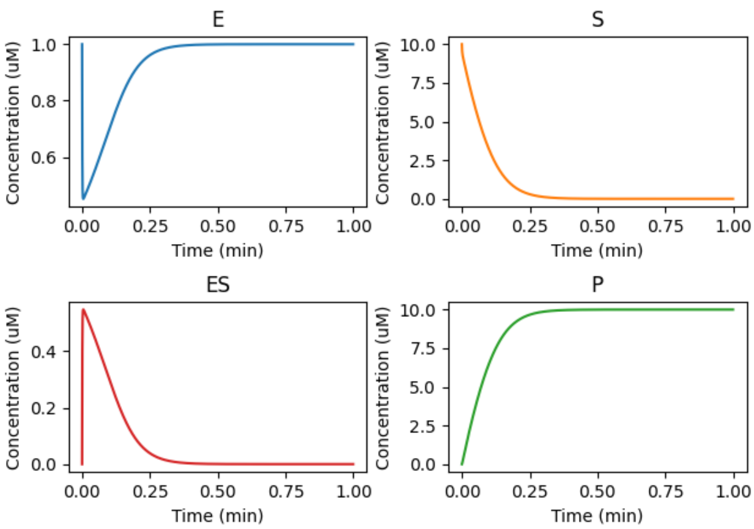

Figure 1 Concentration Change of Four Species

8.3

The code for plotting V is also included in q2.py. As shown in *Figure 2*, at small concentration of S, V increases almost linearly and reach the maximum $V_m = 82.22$, when $S = 9.08$. This plot is saved as v_plot.png.

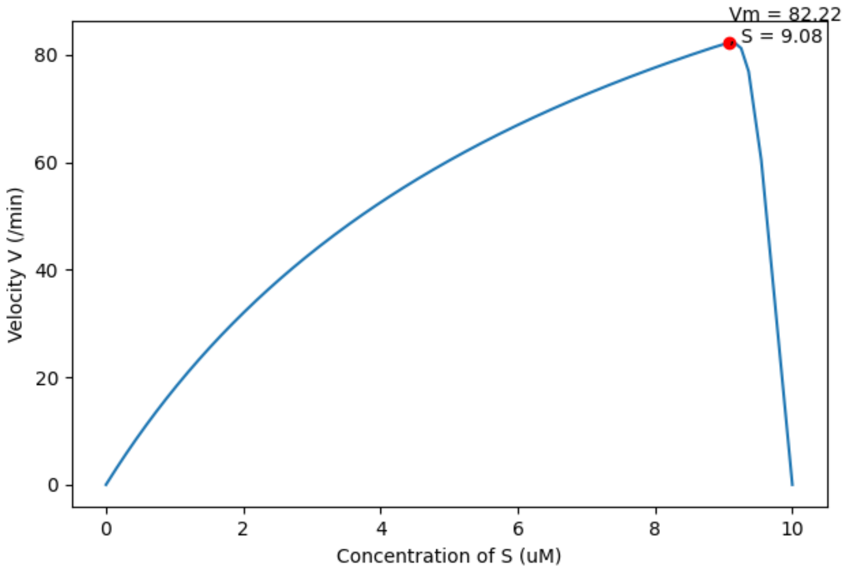

Figure 2 Velocity against Concentration of S