Answer for Question 2

8.1

Equations for the rate of changes of the four species, E, S, ES, and P:

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

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

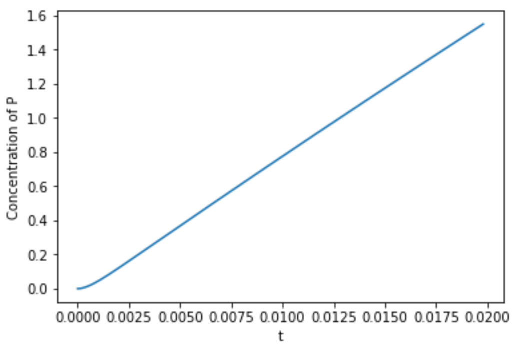
$$\frac{d[ES]}{dt} = k_1[E][S] - (k_2 + k_3)[ES]$$

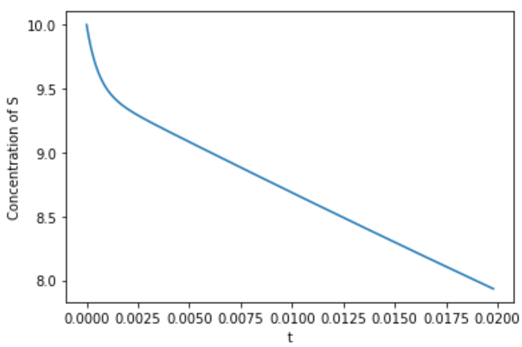
$$\frac{d[E]}{dt} = -k_1[E][S] + (k_2 + k_3)[ES]$$

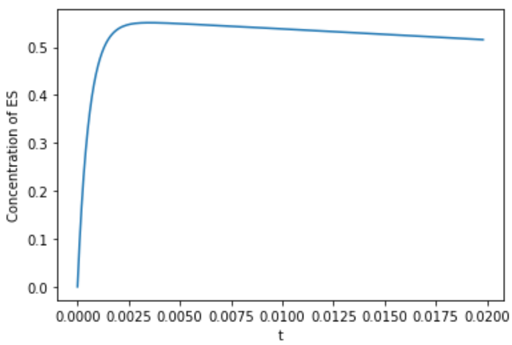
[P], [S], [ES], [E] represents the concentration of P, S, ES, E.

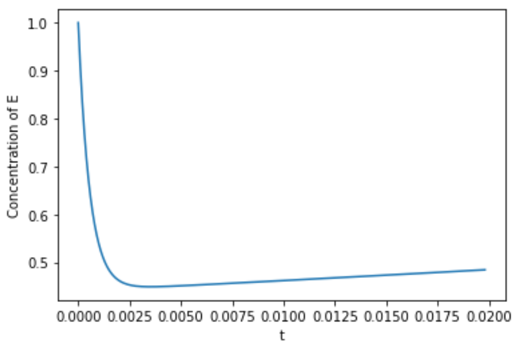
8.2

According to the fourth-order RungeKutta method and the conditions given by the topic, the concentrations of P, S, ES, E change with time as shown in the following plots. The plots reflect the progress of the reaction within 0.02 minutes.



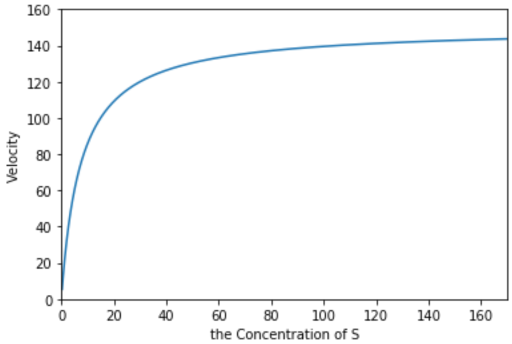






8.3

The function image of the velocity with the concentration of S is shown in the following plot. The initial concentration of E is 1 μM, the initial concentration of S is 175 μM, and the initial concentrations of ES and P are both 0.



From the plot, we can see that the maximum value of velocity is between 140μM/min and 160μM/min. According to Michaelis Equation, $V_m = k_3[E_t]$. $[E_t]$ is the total concentration of [E] and [ES] in the system, which is determined by the feed at the beginning of the reaction. So in theory, $V_m = k_3[E_t] = 150\mu M/min$, which is consistent with the function image drawn by the code.

In conclusion, from the plot, I find the maximum value of velocity is $150\mu M/min$.