Solutions to Q2

1.

Suppose the rate of changes of the 4 species E, S, ES, P are:

$$V_E, V_S, V_{ES}, V_P$$

and the concentrations of E, S, ES, P are:

$$[E], [S], [ES] \text{ and } [P]$$

Then the four rates could be written as below according to the reaction formula:

$$V_E = k_1[E][S] - k_2[ES] - k_3[ES]$$
$$V_S = k_1[E][S] - k_2[ES]$$
$$V_{ES} = k_1[E][S] - k2[ES] - k_3[ES] = V_E$$
$$V_P = k_3[ES]$$

2.

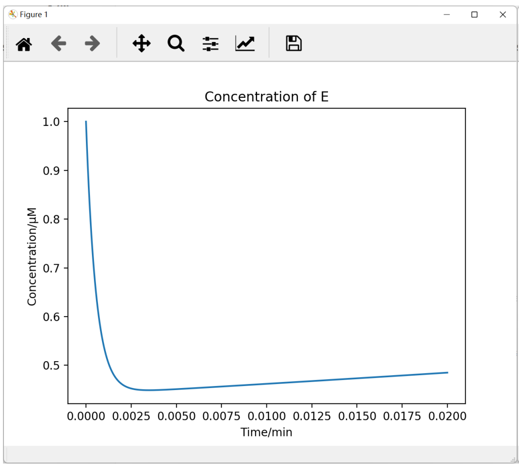
It could be noticed that the reacting rate equals to the time derivative of concentration, thus these four equations could be converted to:

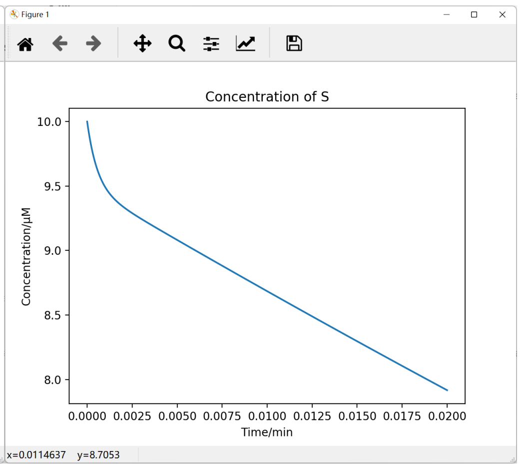
$$\frac{d[E]}{dt} = k_1[E][S] - k_2[ES] - k_3[ES]$$
$$\frac{d[S]}{dt} = k_1[E][S] - k_2[ES]$$
$$\frac{d[ES]}{dt} = k_1[E][S] - k_2[ES] - k_3[ES]$$
$$\frac{d[P]}{dt} = k_3[ES]$$

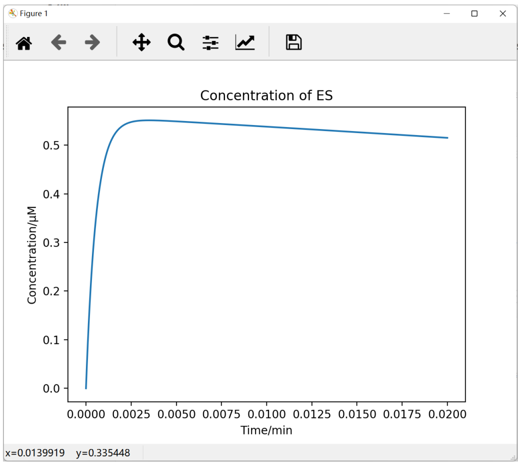
This is actually the same format of **Runge-Kutta** method and these 4 equations could be concluded as:

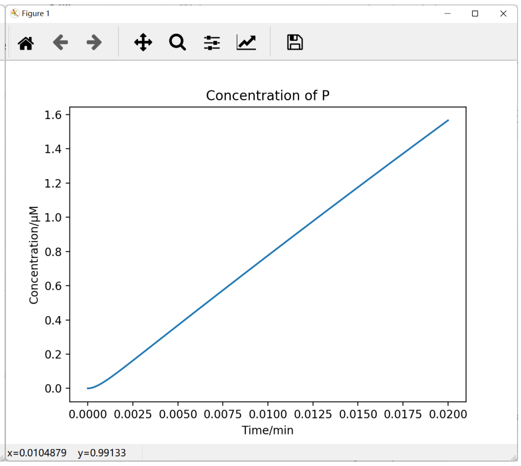
$$y' = f(t, y), y(t_0) = y_0$$

and I use **Python** to perform **Runge-Kutta** method to get the concentration/time plots:



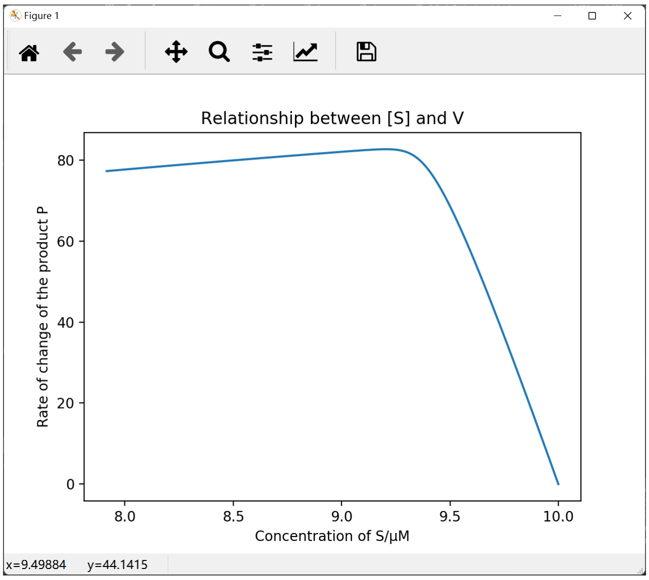






3.

To get the relationship between $V=k_3[ES]$ and [S], I collect the data of [ES] and [S] at every same time point and the result is shown as below:



It can be concluded that the maximum velocity of the product P is:

$$V_{max} = 82.9\ \mu M/min$$