Definition:
$[E]$ the enzyme concentration
$[S]$ the substrate concentration
$[ES]$ the intermediate species concentration
$[P]$ the product concentration
$[E]_0$ the enzyme initial concentration
k_1 the rate constant in the forward reaction to produce ES
k_2 the rate constant in the reverse reaction to produce E and S
k_3 the rate constant for product P formation reaction
M the Michaelis constant. And $M = (k_2 + k_3)/k_1$.
V the velocity of the enzymatic reaction to be the rate of change of P

8.1
According to the law of mass action, four differential equations are given,

$$\begin{cases} \dfrac{\mathrm{d}[E]}{\mathrm{d}t} = (k_2 + k_3)[ES] - k_1[E][S], \\ \dfrac{\mathrm{d}[S]}{\mathrm{d}t} = k_2[ES] - k_1[E][S], \\ \dfrac{\mathrm{d}[ES]}{\mathrm{d}t} = k_1[E][S] - (k_2 + k_3)[ES], \\ \dfrac{\mathrm{d}[P]}{\mathrm{d}t} = k_3[ES]. \end{cases}$$

8.2
According to assumptions, the equations in 8.1 are with initial values,

$$[E]_0 = 1, [S]_0 = 10, [ES]_0 = 0, [P]_0 = 0.$$

Then use the fourth-order Runge-Kutta method. For the specific code, see python file named **Question2_2.py**.
Note that for ease of calculation and display, turn rate constants into 1/1000th of theirs. So as the initial values.
Plot concentration each substance as a function of time(min), which is shown in Fig1.

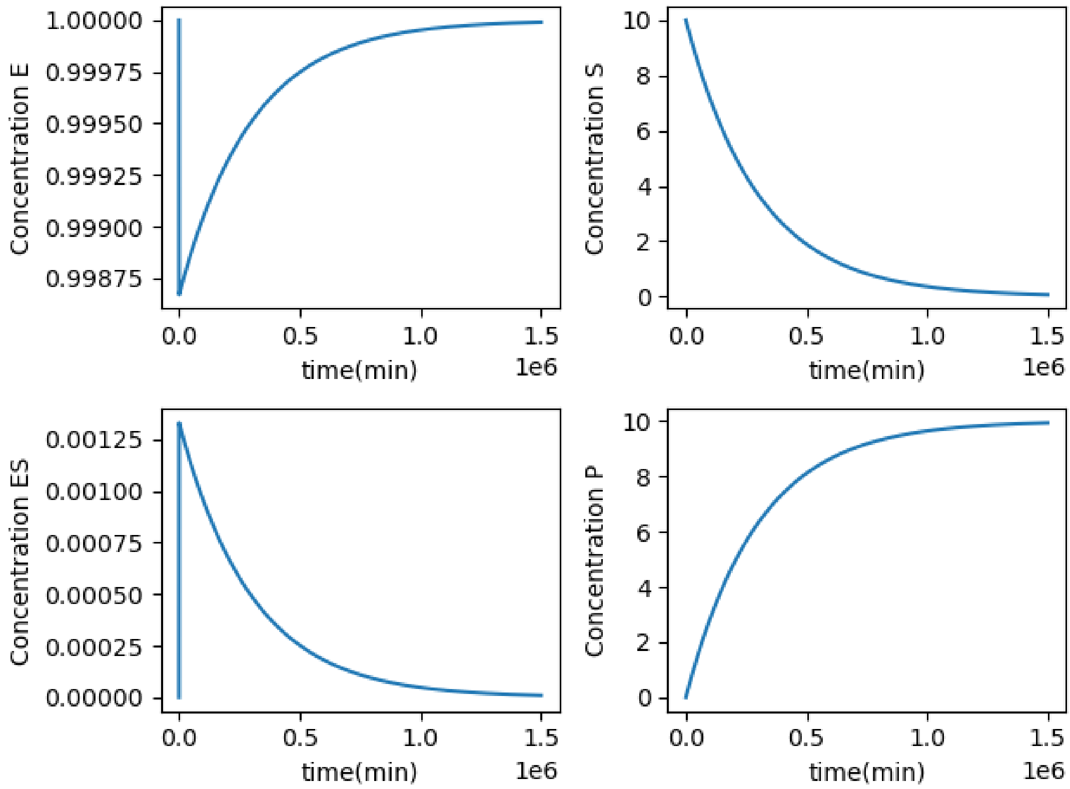

Fig 1

8.3

The Michaelis-Menten equation gives the function with $[S]$ as the argument and V as the dependent variable:

$$V = \frac{k_3[E]_0[S]}{M + [S]}.$$

Plot V-$[S]$ in Fig 2. See the code in python file named **Question2_3.py**

Based on 8.2, it is known that the domain of this function is $[0,10]$. So the maximum value $V_m = 85.71$ (when $[S] = 10$). It can also be found in the plot.

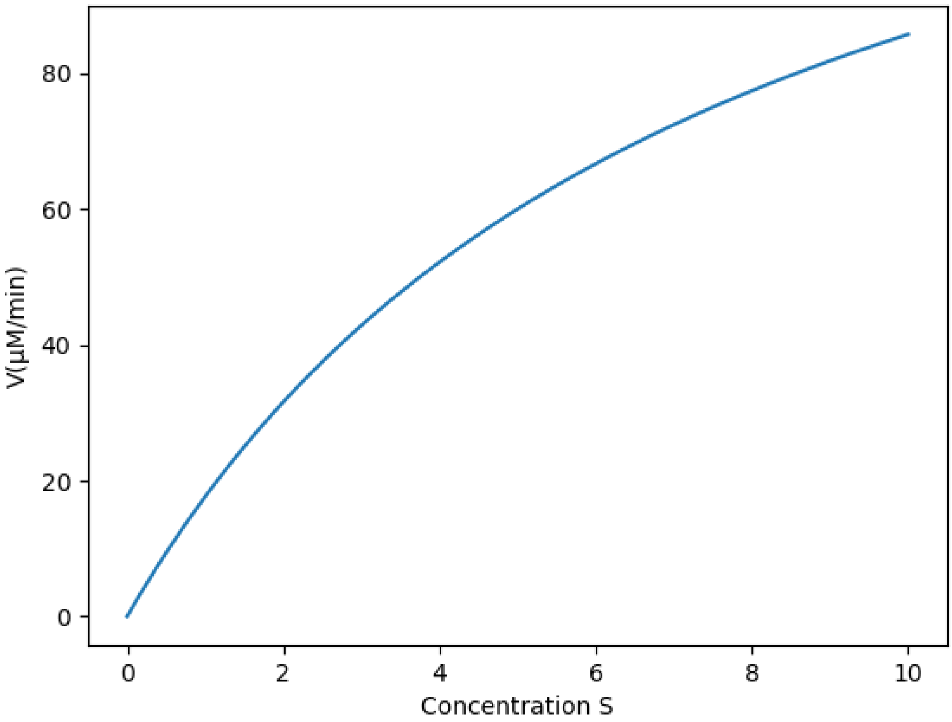

Fig 2