Result:

8.1. Using the law of mass action, write down four equations for the rate of changes of the four species, E, S, ES, and P.

The law of mass action:

The reaction rate of chemical reaction is directly proportional to the product of the power of the concentration of each reactant.

define r as the rate of change

define m as the concentration of species

$$\therefore\ r_E = k_2 m_{ES} + k_3 m_{ES} - k_1 m_E m_S$$

$$r_S = k_2 m_{ES} - k_1 m_E m_S$$

$$r_{ES} = k_1 m_E m_S - k_2 m_{ES} - k_3 m_{ES}$$

$$r_P = k_3 m_{ES}$$

8.2. Write a code to numerically solve these four equations using the fourth-order Runge-Kutta method.

Re = 0 + 0 - 1000 = -1000

Rs = 0 - 1000 = -1000

Res = 1000 - 0 - 0 = 1000

Rp = 0

8.3. We define the velocity, V, of the enzymatic reaction to be the rate of change of the product P. Plot the velocity V as a function of the concentration of the substrate S. You should find that, when the concentrations of S are small, the velocity V increases approximately linearly. At large concentrations of S, however, the velocity V saturates to a maximum value, Vm. Find this value Vm from your plot.

∵ When calculating v by m_s, m_s does not change
(The chemical reaction is instantaneous)

∴ $r_s = 0$

∴ $k_2 m_{ES} - k_1 m_E m_s = 0$

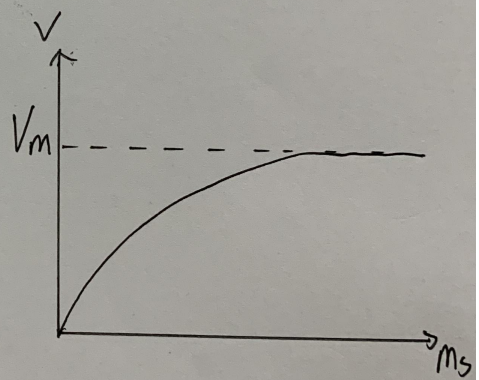
∵ The total amount of specie E is a constant
and define T as the total amount

∴ $m_{ES} + m_E = T$

∴ $m_E = T - m_{ES}$

∴ $k_2 m_{ES} = k_1 m_s \cdot (T - m_{ES})$

$$m_{ES} = \frac{T k_1 m_s}{k_2 + k_1 m_s}$$



∵ $r_p = V = k_3 m_{ES}$

∴ $$V = \frac{k_3 k_1 T m_s}{k_2 + k_1 m_s} = \frac{k_3 T m_s}{\frac{k_2}{k_1} + m_s}$$

∴ $V_m = k_3 T$,

$$= k_3 T \cdot \frac{m_s}{\frac{k_2}{k_1} + m_s} < k_3 T$$

T is the total amount of E