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*.

$$E + S \underset{k_2}{\overset{k_1}{\rightleftharpoons}} ES \xrightarrow{k_3} E + P$$

(1)

E 生成： $V = k_2[ES] + k_3[ES] - k_1[E][S]$

S 生成： $V = k_2[ES] - k_1[ES]$

ES 生成： $V = k_1[E][S] - k_2[ES] - k_3[ES]$

P 生成： $V = k_3[ES]$

8.2. Write a code to numerically solve these four equations using the**fourth-order Runge-Kutta method**. For this exercise, assume that the initggggggggggggggggial concentration of *E* is 1 µM, the initial concentration of *S* is 10 µM, and the initial concentrations of *ES* and *P* are both 0. The rate constants are: *k1*=100/µM/min, *k2*=600/min, *k3*=150/min.

$$y'_E = f(t, y_E, y_s, y_{ES}, y_P)$$

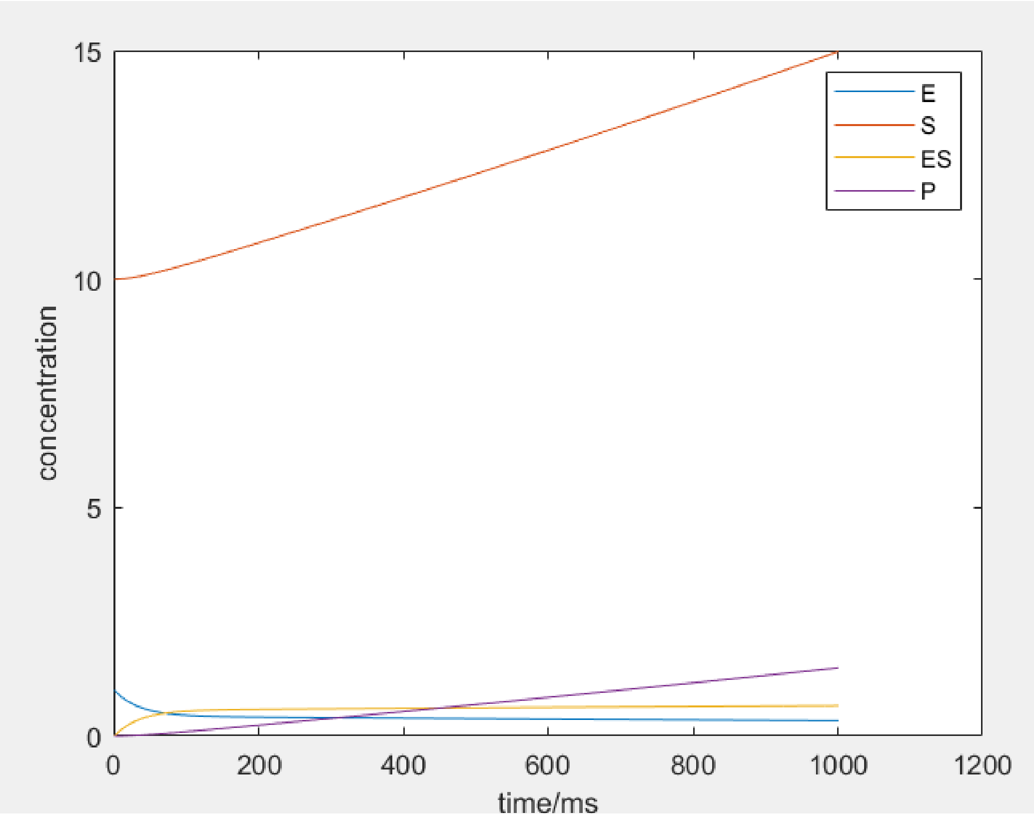
$$[E]_{n+1} = [E]_n + \frac{h}{6}(k_1 + 2k_2 + 2k_3 + k_4)$$

$$k_1 = f(t_n, y_n)$$

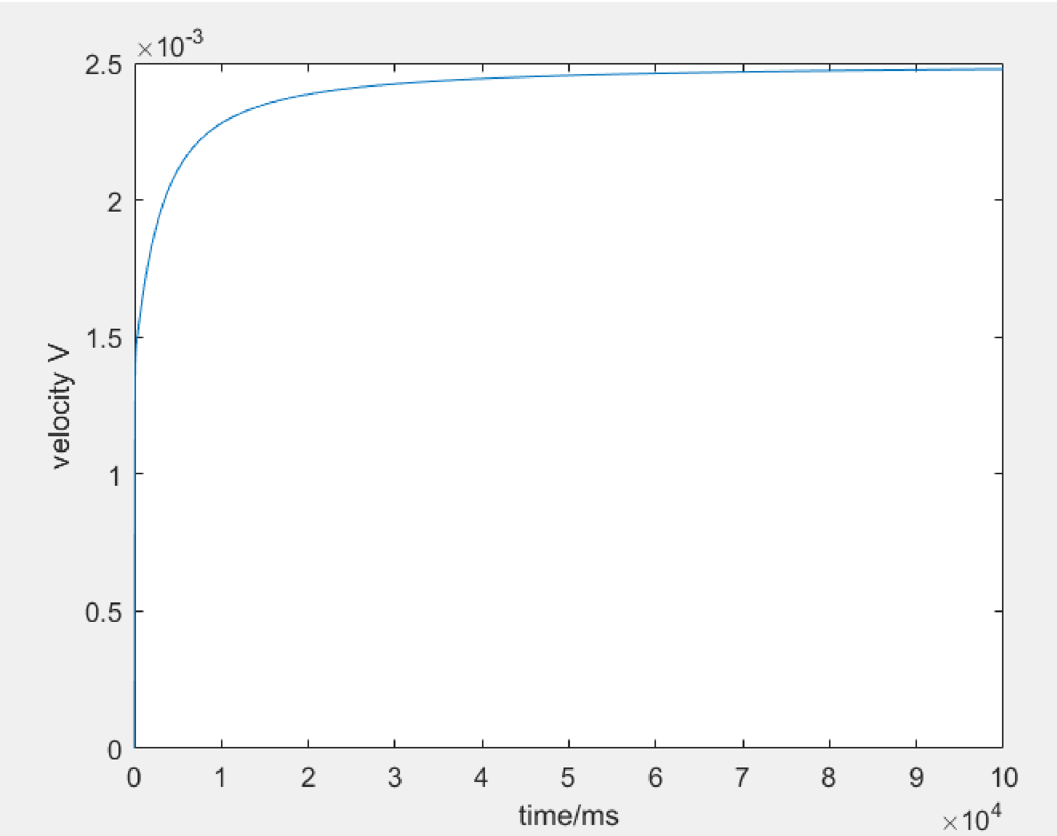
$$k_2 = f\left(t_n + \frac{h}{2}, y_n + \frac{h}{2}k_1\right)$$

$$k_3 = f\left(t_n + \frac{h}{2}, y_n + \frac{h}{2}k_2\right)$$

$$k_4 = f(t_n + h, y_n + hk_3)$$



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 yourplot.



The required vmax is 0.0025 μM/m(2.5μM/s or 150μM/min)