<u>Question 2: Enzyme Kinetics</u>

<u>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.</u>

Ans:

The law of mass action states that the rate of reaction is proportional to the product of the concentrations of the reactants. Let [*E*], [*S*], [*ES*] and [*P*] be the concentration of *E*, *S*, *ES* and *P respectively.*

For the rate of change of P:

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

For the rate of change of ES:

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

For the rate of change of E:

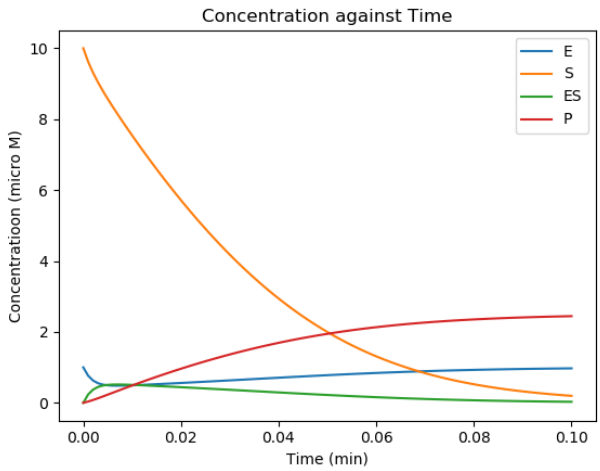
$$\frac{d[E]}{dt} = k_2[ES] + k_3[ES] - k_1([E][S])$$

For the rate of change of S:

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

<u>8.2 Write a code to numerically solve these four equations using the fourth-order Runge-Kutta method. For this exercise, assume that the initial 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/min, k2=600/min, k3=150/min.</u>

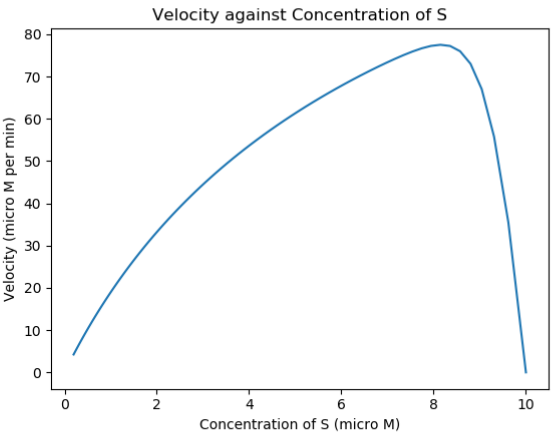
Ans:



Code in Github repo.

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.

Ans:



From the plot, $Vm \approx 80$ μM/min.