8.1

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

The above equation represents enzyme E converting substrate S with 'k_1' as rate constant of forward reaction to produce intermediate product ES, and 'k_2' as rate constant of backward reaction to dissipate ES to E and S. The intermediate ES produces E and P with rate constant of 'k_3'.

According to the law of mass action, the rate of chemical reaction is directly proportional to the product of concentration of each reactant.

We can divide the equations into 2 parts as follows :

i) $$E + S \underset{k_2}{\overset{k_1}{\rightleftharpoons}} ES$$

ii) $$ES \xrightarrow{k_3} E + P$$

For equation i), we can calculate the rate of forward reaction and reverse reaction :

a) $$rate_{forward1} = k_1 [E][S]$$

[contd.]

b) $$rate_{reverse} = K_2[ES]$$

For equation ii), we only need to calculate the rate of forward reaction :

a) $$rate_{forward2} = K_3[ES]$$

Now we can calculate the rate of change of species of E, S, ES, P.

A. For determining rate of change of P, only the intermediate species ES is responsible for producing it from equation ii) , hence we get the following :

$$\frac{\Delta[P]}{\Delta t} = K_3[ES]$$

[contd.]

B. Rate of change in species S is dependent on its forward rate constant to create ES intermediate and its reverse rate constant for ES to dissipate into E and S from equation i)

$$\frac{\Delta[S]}{\Delta t} = -k_1[E][S] + k_2[ES]$$

C. Rate of change of E is dependent on its dissipation from ES from its reverse reaction and E's formed as a product from ES as reactant as well as E as a reactant from equation i)

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

D. Rate of change of ES as a species is dependent on the formation of ES from equation i) and dissipation of ES and formation of products in equation ii)

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

8.2, 8.3 Not Attempted.