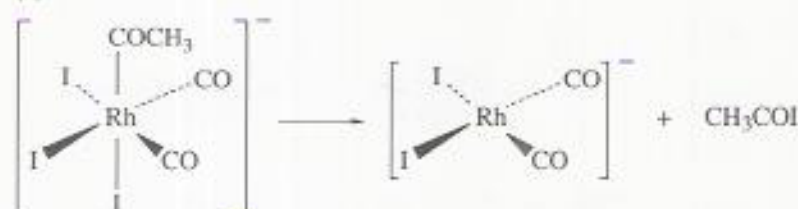


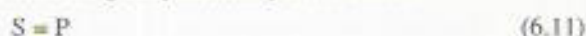
(a)



(b)

Figure 6.1 Two reactions, for use with Q6.12, key items C and D.

**Q6.13 and Q6.14** These questions are concerned with the following enzyme-catalysed reaction:



For a fixed concentration of enzyme,  $[\text{E}]_0$ , added to the reaction mixture, the reaction follows Michaelis-Menten kinetics; that is, it has the following dependence of initial rate,  $J_0$ , on initial substrate concentration,  $[\text{S}]_0$ :

$$J_0 = \frac{V[\text{S}]_0}{K_m + [\text{S}]_0} \quad (6.12)$$

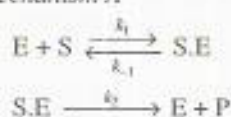
**Q6.13** Use the information provided to select the *one incorrect* statement from the key.

KEY for Q6.13

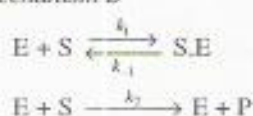
- A A plot of  $[\text{S}]_0/J_0$  against  $[\text{S}]_0$  should be a straight line with a slope equal to  $1/V$ .
- B When  $[\text{S}]_0 \ll K_m$ , a plot of  $\ln J_0$  versus  $\ln [\text{S}]_0$  is a straight line of gradient 1.
- C At high substrate concentrations, a plot of  $J_0$  versus  $[\text{S}]_0$  levels off at the value  $J_0 = V$ .
- D If a plot of  $1/J_0$  against  $1/[\text{S}]_0$  is a straight line with slope equal to  $4.0 \times 10^3 \text{ s}$  and intercept (when  $1/[\text{S}]_0 = 0$ ) equal to  $2.0 \times 10^6 \text{ mol}^{-1} \text{ dm}^3 \text{ s}$ , then the value of  $K_m$  for this enzyme is equal to  $5.0 \times 10^2 \text{ mol dm}^{-3}$ .
- E The value of  $K_m$  governs the range of substrate concentrations over which the initial rate approaches its limiting value.
- F Considering initial rates, when  $K_m \ll [\text{S}]_0$ , the reaction is zeroth order with respect to the substrate.

**Q6.14** Two possible mechanisms for the enzyme-catalysed reaction in equation 6.11 are as follows:

*Mechanism A*



*Mechanism B*



The chemical rate equation predicted by *Mechanism A* is given by the following expression:

$$J_0 = \frac{k_2[\text{S}]_0[\text{E}]_0}{\left\{ \left( \frac{k_{-1} + k_2}{k_1} \right) + [\text{S}]_0 \right\}} \quad (6.13)$$

Examine the statements in the key and select *two* that are **incorrect**.

KEY for Q6.14

- A According to *Mechanism A*, the concentration of the free enzyme is given by  $[\text{E}] = [\text{E}]_0 - [\text{S.E}]$ .
- B According to *Mechanism A*, if  $k_{-1} \gg k_2$ , then  $K_m = K_D$ , where  $K_D$  is the dissociation constant of the enzyme-substrate complex:
 
$$\text{S.E} \xrightleftharpoons{K_D} \text{S} + \text{E}$$
- C According to *Mechanism A*, if  $K_m \ll [\text{S}]_0$ , the concentration of the free enzyme is similar to that of the enzyme that was added to the initial reaction mixture ( $[\text{E}]_0$ ).
- D In *Mechanism B*, the substrate-enzyme complex, S.E, is not part of the catalysed route from reactant to product.
- E If a pre-steady-state study of reaction 6.11 shows a 'burst' in the rate of product formation at the start of the reaction, this suggests that the reaction path is more likely to be *Mechanism A* than *Mechanism B*.

#### PART E (Topic Study 1)

**Q6.15** As a global and annual average, the temperature and pressure at an altitude of 35 km can be taken to be  $T = 235.1 \text{ K}$  and  $p = 5.4 \text{ mbar}$ , and the mixing ratio of ozone,  $\text{O}_3$ , is typically 8.0 p.p.m.v. Use this information, together with the ideal gas equation, to estimate the concentration (or strictly, the number density) of ozone at 35 km. Select from the key the value that is closest to your answer.

KEY for Q6.15

- |                                        |                                        |
|----------------------------------------|----------------------------------------|
| A $1.3 \times 10^{12} \text{ cm}^{-3}$ | E $1.3 \times 10^{18} \text{ cm}^{-3}$ |
| B $2.1 \times 10^{12} \text{ cm}^{-3}$ | F $2.1 \times 10^{18} \text{ cm}^{-3}$ |
| C $1.3 \times 10^{13} \text{ cm}^{-3}$ | G $1.3 \times 10^{24} \text{ cm}^{-3}$ |
| D $2.1 \times 10^{13} \text{ cm}^{-3}$ | H $2.1 \times 10^{24} \text{ cm}^{-3}$ |