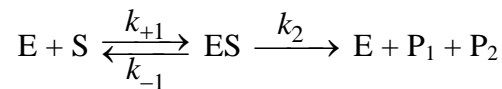


Problem 4-09 Integrated Michaelis-Menten equation; $c_{S0} \ll K_M$; molar enzyme activity

Michaelis constant $K_M = 226 \text{ mmol dm}^{-3}$ was evaluated from the measurements of initial reaction rates for the enzymatic reaction described by the following scheme:



At enzyme concentration $2.17 \cdot 10^{-6} \text{ mol dm}^{-3}$ the concentration of substrate ($M_S = 150 \text{ g mol}^{-1}$) decreased to 40 % of the initial value $3 \mu\text{g cm}^{-3}$ in 1.2 hour. Calculate the molar activity of the enzyme catalyzing the above mentioned reaction. [$k_2 = 22.09 \text{ s}^{-1}$]

Solution:

$$w_{S0} = 3 \mu\text{g cm}^{-3} = 3 \cdot 10^{-6} \text{ g (} 10^3 \text{ dm}^{-3} \text{)} = 3 \cdot 10^{-3} \text{ g dm}^{-3}$$

$$M_S = 150 \text{ g mol}^{-1}$$

$$\left. \begin{aligned} c_{S0} &= \frac{w_{S0}}{M_S} = \frac{3 \cdot 10^{-3}}{150} = 2 \cdot 10^{-5} \text{ mol dm}^{-3} \\ K_M &= 226 \text{ mmol dm}^{-3} = 0.226 \text{ mol dm}^{-3} \end{aligned} \right\} c_{S0} \ll K_M$$

$$\tau = 1.2 \text{ h} = 4320 \text{ s}$$

$$c_S = 0.4 c_{S0}$$

$$c_{E0} = 2.17 \cdot 10^{-6} \text{ mol dm}^{-3}$$

$$v = \frac{dc_P}{d\tau} = -\frac{dc_S}{d\tau} = \frac{v_{\max} \cdot c_S}{K_M + c_S} \cong \frac{v_{\max}}{K_M} \cdot c_S$$

- first-order kinetics with the rate constant $= v_{\max}/K_M$

$$-\int_{c_{S0}}^{c_S} \frac{dc_S}{c_S} = \frac{v_{\max}}{K_M} \cdot \int_0^{\tau} d\tau$$

$$-\ln \frac{c_S}{c_{S0}} = \frac{v_{\max}}{K_M} \cdot \tau, \quad v_{\max} = k_2 \cdot c_{E0}$$

$$k_2 = \frac{K_M}{c_{E0} \cdot \tau} \cdot \ln \frac{c_{S0}}{c_S} = \frac{0.226}{2.17 \cdot 10^{-6} \cdot 4320} \cdot \ln \frac{c_{S0}}{0.4 c_{S0}} = 22.09 \text{ s}^{-1}$$