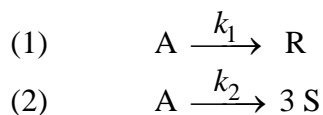


### Problem 2-07 Parallel reactions

Two side first-order reactions



take place in a constant-volume vessel at constant temperature of 350 K. In 20.2 minutes from the beginning of the reaction the concentration of the product R reached 40 % of initial concentration of the reactant A and that of the product S 66 % of initial concentration of the reactant A.

(a) What is the concentration of A in this instant (in per cents of initial amount of A).

(b) Calculate the values of both rate constants.

$$[(a) c_A = 0.38 c_{A0}, (b) k_1 = 0.0309 \text{ min}^{-1}, k_2 = 0.017 \text{ min}^{-1}]$$

**Solution:**

$$\tau = 20.2 \text{ min}, \quad c_R = 0.4 c_{A0}, \quad c_S = 0.66 c_{A0}$$

Balance:

$$c_A = c_{A0} - x_1 - x_2$$

$$c_R = x_1 \dots\dots\dots x_1 = 0.4 c_{A0}$$

$$c_S = 3 x_2 \dots\dots\dots x_2 = \frac{c_S}{3} = \frac{0.66}{3} c_{A0} = 0.22 c_{A0}$$

$$\Sigma c = c_A + c_R + c_S = c_{A0} + 2x_2$$

$$(a) c_A = c_{A0} - 0.4 c_{A0} - 0.22 c_{A0} = 0.38 c_{A0}$$

$$(b) r = r_A = -\frac{dc_A}{d\tau} = (k_1 + k_2) \cdot c_A$$

$$\ln \frac{c_{A0}}{c_A} = (k_1 + k_2) \cdot \tau \dots\dots\dots k_1 + k_2 = \frac{1}{\tau} \cdot \ln \frac{c_{A0}}{c_A} = \frac{1}{20.2} \cdot \ln \frac{c_{A0}}{0.38 c_{A0}} = 0.0479 \text{ min}^{-1}$$

$$\left. \begin{array}{l} r = \frac{dc_R}{d\tau} = k_1 \cdot c_A \\ r = \frac{dc_S}{3d\tau} = k_2 \cdot c_A \end{array} \right\} \quad \frac{dc_S}{dc_R} = \frac{3k_2}{k_1} \Rightarrow \frac{k_2}{k_1} = \frac{c_S}{3c_R} = \frac{0.66}{3 \cdot 0.4} = 0.55$$

$$k_1 + 0.55 k_1 = 0.0479 \text{ min}^{-1}$$

$$k_1 = \frac{0.0479}{1.55} = 0.0309 \text{ min}^{-1}$$

$$k_2 = 0.55 k_1 = 0.017 \text{ min}^{-1}$$