7. SIMULTANEOUS CHEMICAL EQUILIBRIA

Problem 7-01 Two simultaneous reactions in solution, calculation of equilibrium constants

Two simultaneous reactions, which can be schematically written as

$$\mathrm{A\ (aq) = R\ (aq) + 2S\ (aq)} \qquad (1)$$

$$\mathrm{A\ (aq) = B\ (aq)} \qquad (2)$$

are taking place in a solution initially containing only A in concentration c_{A0} = 0.15 mol dm^{-3}. Equilibrium mixture of A, B, R, and S contained 28.57 mol. % S and 35.71 mol. % B. Calculate equilibrium constants of both reactions assuming that all activity coefficients are equal to one. Standard state: infinite dilution, c^{st} = 1 mol dm^{-3}.

[$K_1 = 2.4 \cdot 10^{-3}$; $K_2 = 1.667$]

Problem 7-02 Two simultaneous reactions in solution, calculation of equilibrium constants

In a solution initially containing the components A and R in concentrations c_{A0} = 0.07 mol dm^{-3} and c_{R0} = 0.25 mol dm^{-3} two simultaneous reactions are taking place:

$$\mathrm{R\ (aq) = D\ (aq) + S\ (aq)} \qquad (1)$$

$$\mathrm{A\ (aq) + R\ (aq) = 2\ B\ (aq)} \qquad (2)$$

Equilibrium mixture of A, R, B, D, and S contained 20 mol. % D and 22 mol. % B. Calculate the equilibrium constants for the standard states infinite dilution, c^{st} = 1 mol dm^{-3}. Activity coefficients can be considered as equal to one.

[$K_1 = 0.0508$; $K_2 = 2.3639$]

Problem 7-03 Two simultaneous reactions in solution, calculation of equilibrium composition

Substance A decomposes in two possible ways

$$\mathrm{A = R + S} \qquad (1)$$

$$\mathrm{A = B + D} \qquad (2)$$

The equilibrium constants have the following values for the standard state infinite dilution, c^{st} = 1 mol dm^{-3}: $K_1 = 0.32$ and $K_2 = 1.28$. The equilibrium solution contains all components, A, B, D, R, and S. What is its composition (in mol. %)? The initial solution contained only the substance A in concentration c_{A0} = 0.1 mol dm^{-3}. Assume that activity coefficients are equal to one.

[1.652 mol. % A; 16.391 mol. % R; 16.391 mol. % S; 32.783 mol. % B; 32.783 mol. % D]