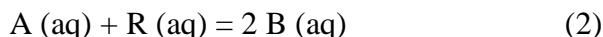
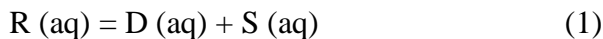


**Problem 7-02 Two simultaneous reactions in solution, calculation of equilibrium constants**

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



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,  $c^{\text{st}} = 1 \text{ mol dm}^{-3}$ . Activity coefficients can be considered as equal to one.

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

**Solution:**

$$\begin{aligned} c_{A0} &= 0.07 \text{ mol dm}^{-3} \\ c_{R0} &= 0.25 \text{ mol dm}^{-3} \\ c^{\text{st}} &= 1 \text{ mol dm}^{-3} \end{aligned}$$

**Balance:**

$$c_R = c_{R0} - x_1 - x_2$$

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

$$c_D = x_1$$

$$c_S = x_1$$

$$c_B = 2 x_2$$

$$\Sigma C = c_{A0} + c_{R0} + x_1$$

$$\frac{c_D}{\Sigma C} = \frac{x_1}{c_{A0} + c_{R0} + x_1} = 0.2 \Rightarrow x_1 = \frac{0.32 \cdot 0.2}{1 - 0.2} = 0.08$$

$$\frac{c_B}{\Sigma C} = \frac{2 x_2}{c_{A0} + c_{R0} + x_1} = 0.22 \Rightarrow x_2 = \frac{1}{2} \cdot 0.22 \cdot (0.07 + 0.25 + 0.08) = 0.044$$

$$K_1 = \frac{a_D \cdot a_S}{a_R} = \frac{c_D \cdot c_S}{c_R} \cdot \frac{1}{c^{\text{st}}} = \frac{x_1 \cdot x_1}{c_{R0} - x_1 - x_2} = \frac{0.08^2}{0.25 - 0.08 - 0.044}$$

$$K_1 = 0.050794$$

$$K_2 = \frac{a_B^2}{a_A \cdot a_R} = \frac{c_B^2}{c_A \cdot c_R} = \frac{(2 x_2)^2}{(c_{A0} - x_2) \cdot (c_{R0} - x_1 - x_2)} = \frac{4 \cdot 0.044^2}{(0.07 - 0.044) \cdot (0.25 - 0.08 - 0.044)}$$

$$K_2 = 2.3639$$