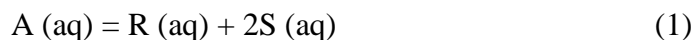


### Problem 7-01 Two simultaneous reactions in solution, calculation of equilibrium constants

Two simultaneous reactions, which can be schematically written as



are taking place in a solution initially containing only A in concentration  $c_{A0} = 0.15 \text{ mol dm}^{-3}$ . 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,  $c^{\text{st}} = 1 \text{ mol dm}^{-3}$ .

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

**Solution:**

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

$$c_R = x_1$$

$$c_S = 2 x_1$$

$$c_B = x_2$$

$$\Sigma c = c_{A0} + 2 x_1$$

$$c_{A0} = 0.15 \text{ mol dm}^{-3}$$

$$c^{\text{st}} = 1 \text{ mol dm}^{-3}$$

$$\frac{c_S}{\Sigma c} = \frac{2 x_1}{c_{A0} + 2 x_1} = 0.2857 \Rightarrow x_1 = \frac{0.2857 \cdot 0.15}{2 \cdot (1 - 0.2857)} = 0.03$$

$$\frac{c_B}{\Sigma c} = \frac{x_2}{c_{A0} + 2 x_1} = 0.3571 \Rightarrow x_2 = 0.3571 \cdot (0.15 + 2 \cdot 0.03) = 0.075$$

$$K_1 = \frac{a_R \cdot a_S^2}{a_A} = \frac{c_R \cdot c_S^2}{c_A} \cdot \frac{1}{(c^{\text{st}})^2} = \frac{x_1 \cdot (2 x_1)^2}{c_{A0} - x_1 - x_2} = \frac{4 \cdot 0.03^3}{0.15 - 0.03 - 0.075} = 2.4 \cdot 10^{-3}$$

$$K_2 = \frac{a_B}{a_A} = \frac{c_B}{c_A} = \frac{x_2}{c_{A0} - x_1 - x_2} = \frac{0.075}{0.15 - 0.03 - 0.075} = 1.667$$