5. GIBBS ENERGY AND DIRECTION OF CHEMICAL REACTION

Problem 5-01 Reaction Gibbs energy and direction of chemical reaction

The standard reaction Gibbs energy of the reaction

2-P-glycerate^{3-} = 2-P-enolpyruvate^{3-} + H_2O (ℓ)

at the temperature of 37.3 °C is $\Delta_r G^{\ominus}$ = –2.68 kJ mol^{-1} (standard states: infinite dilution, c^{st} = 1 mol dm^{-3}, for solutes, pure substance at given temperature and pressure). Find out if this reaction is exergonic or endergonic at standard conditions. Calculate the reaction Gibbs energy of the reaction in the instant when the concentrations of components are

(a) c(2-P-glycerate^{3-}) = 0.015 mol dm^{-3} and c(2-P-enolpyruvate^{3-}) = 0.032 mol dm^{-3}

(b) c(2-P-glycerate^{3-}) = 5·10^{-2} mol dm^{-3} and c(2-P-enolpyruvate^{3-}) = 7.5·10^{-4} mol cm^{-3}

Decide if the reaction will go to the products or to the reactants. Assume that all activity coefficients are equal to one.

[$\Delta_r G^{\ominus} < 0$ – exergonic; (a) $\Delta_r G$ = –724.3 J mol^{-1} – the reaction goes to products;
(b) $\Delta_r G$ = +3940.3 J mol^{-1} – the reaction goes to reactants]

Problem 5-02 Reaction Gibbs energy and direction of chemical reaction

The reaction

glucose-1-phosphate = glucose-6-phosphate,

catalyzed by phosphoglucomutase, is a part of carbohydrate metabolism. The equilibrium constant at 25 °C, K = 18.8 is valid for the standard state infinite dilution, c^{st} = 1 mol dm^{-3}. Find out what will arise in the mixture containing both components in concentrations 5.55 mmol dm^{-3} of glucose-1-phosphate and 0.555 mol dm^{-3} of glucose-6-phosphate: 1-phosphate or 6-phosphate? What will be the composition of the equilibrium mixture? Assume that all activity coefficients are equal to one.

[$\Delta_r G$ = 4.14 kJ mol^{-1} > 0 , glucose-1-phosphate is formed,
equilibrium mixture contains 94.95 mol. % of glucose-6-phosphate]

Problem 5-03 Reaction Gibbs energy and direction of chemical reaction

The equilibrium constant of the reaction

glucose-1-phosphate = glucose-6-phosphate

at the temperature of 38 °C is K = 16.707 (the standard state: infinite dilution, c^{st} = 1 mol dm^{-3}, activity coefficients are equal to one). Find out if this reaction in the mixture of 8.2 mmol dm^{-3} of glucose-1-phosphate and 0.137 mol dm^{-3} glucose-6-phosphate will occur spontaneously to glucose-6-phosphate.

[$\Delta_r G$ = 0.049 J mol^{-1} ≈ 0 , reaction is nearly in equilibrium]