

Exam III

Administered: Monday, November 14, 2022

24 points

For each problem part: 0 points if not attempted or no work shown,
 1 point for partial credit, if work is shown,
 2 points for correct numerical value of solution, if work is shown

Problem 1. (14 points)Consider a mixture of four butanediol ($C_4O_2H_{10}$) isomers shown below.

1,2-Butanediol	1,3-Butanediol	1,4-Butanediol	2,3-Butanediol

Equilibrium coefficients, which relate mole fractions of components to one another, are given below:

$$K_{1,3-1,2}^{eq} = x_{1,3}/x_{1,2} = 0.665$$

$$K_{1,4-1,3}^{eq} = x_{1,4}/x_{1,3} = 0.740$$

$$K_{2,3-1,4}^{eq} = x_{2,3}/x_{1,4} = 0.542$$

The sum of the mole fractions is unity.

$$x_{1,2} + x_{1,3} + x_{1,4} + x_{2,3} = 1$$

- (a) Is this system of algebraic equations linear or nonlinear? (2 pts)
 (b) If linear, rearrange the problem as $Ax = b$ and identify A , x and b .
 If nonlinear, rearrange the problem as $J\delta x = -R$ and identify J , δx and R . (6 pts)
 (c) Determine the composition of this mixture. (6 pts)

Problem 2. (10 points)

For the system described in problem 1, the equilibrium coefficients were evaluated at 300 K, using the relation

$$K_{1,3-1,2}^{eq} = \exp\left(-\frac{\Delta G_{1,3-1,2}}{RT}\right) \text{ where } \Delta G_{1,3-1,2} = 1.018 \text{ kJ/mol}$$

$$K_{1,4-1,3}^{eq} = \exp\left(-\frac{\Delta G_{1,4-1,3}}{RT}\right) \text{ where } \Delta G_{1,4-1,3} = 0.750 \text{ kJ/mol}$$

$$K_{2,3-1,4}^{eq} = \exp\left(-\frac{\Delta G_{2,3-1,4}}{RT}\right) \text{ where } \Delta G_{2,3-1,4} = 1.526 \text{ kJ/mol}$$

In Problem 2, you don't know the temperature but you do measure $x_{1,2} = 0.375$.

- (a) Is this system of algebraic equations linear or nonlinear? (2 pts)
 (b) Determine the temperature and the composition of the other three isomers. (8 pts)