Exam III
Administered: Friday, November 5, 2021
16 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. (8 points)
For an ideal mixture, the volume of the mixture, V_{mix}, is given by the sum of the pure component molar volumes, V_i, weighted by the mole fraction, x_i. Similarly, the enthalpy of the mixture, H_{mix}, is given by the sum of the pure component enthalpies, H_i, weighted by the mole fraction. As a reminder, the sum of the mole fractions is unity.

$$V_{mix} = \sum_{i=1}^{n_c} x_i V_i \qquad H_{mix} = \sum_{i=1}^{n_c} x_i H_i \qquad 1 = \sum_{i=1}^{n_c} x_i$$

where n_c is the number of components. Now consider a three component ideal mixture ($n_c = 3$) with the following pure component properties and mixture properties.

component	A	B	C	mixture
molar volume (liter/mol)	19	13	11	15.0
enthalpy (kJ/mol)	42	65	51	52.0

(a) Is this system of algebraic equations linear or nonlinear? (2 pts)
(b) Determine the composition of this mixture. Show reasoning and method. (6 pts)

Problem 2. (8 points)
Consider a non-ideal mixture in which the enthalpy of the mixture is given by the expression

$$H_{mix} = \sum_{i=1}^{n_c} \sum_{j \geq i}^{n_c} (2 - \delta_{ij}) \Omega_{ij} x_i x_j$$

where δ_{ij} is the Kronecker delta function and is 1 for $i = j$ and 0 for $i \neq j$. For a three-component mixture, this equation becomes

$$\begin{aligned} H_{mix} = \Omega_{AA} x_A x_A + 2\Omega_{AB} x_A x_B + 2\Omega_{AC} x_A x_C \\ + \Omega_{BB} x_B x_B \quad + 2\Omega_{BC} x_B x_C \\ + \ \Omega_{CC} x_C x_C \end{aligned}$$

The expressions for the molar volume and sum of the mole fractions remain unchanged from problem 1. The mixing parameters, $\Omega_{ij} = \sqrt{H_i H_j}$, where the pure component enthalpies are given in problem 1. The same numerical values of the mixture properties are observed as those in the problem 1.

(a) Is this system of algebraic equations linear or nonlinear? (2 pts)
(b) Determine the composition of this mixture. Show reasoning and method. (6 pts)