Exam III
Administered: Wednesday, November 10, 2017
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. The cost of the mixture, C_{mix}, is also given by the sum of the pure component costs, C_i, weighted by the mole fraction. As a reminder, the sum of the mole fractions is unity.

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

where n_c is the number of components. Now consider a four component ideal mixture ($n_c = 4$) with the following pure component properties and mixture properties.

component	A	B	C	D	mixture
molar volume (liter/mol)	11	14	17	8	12.8
enthalpy (kJ/mol)	49	74	45	63	57.1
cost ($/mol)	40.18	89.67	38.22	55.99	56.216

(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)

Rework problem 1 for a non-ideal mixture in which the enthalpy of the mixture is given by

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

where the thermodynamic mixing parameters are defined by $\Omega_{ij} = \sqrt{H_i H_j}$ and δ_{ij} is the Kronecker delta function (δ_{ij}=1 for $i = j$ and δ_{ij}=0 for $i \neq j$). For a four-component mixture, this equation becomes

$$\begin{aligned} H_{mix} = {} & \Omega_{AA} x_A x_A + 2\Omega_{AB} x_A x_B + 2\Omega_{AC} x_A x_C + 2\Omega_{AD} x_A x_D \\ & + \Omega_{BB} x_B x_B + 2\Omega_{BC} x_B x_C + 2\Omega_{BD} x_B x_D \\ & + \Omega_{CC} x_C x_C + 2\Omega_{CD} x_C x_D \\ & + \Omega_{DD} x_D x_D \end{aligned}$$

(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)