ChE 312 Chemical Engineering Thermodynamics
Winter 2023 February 6, 2023

Exam #1

Name _____ Student ID _____

Exam Guidelines:

- Non-graphing calculator and pencil/pens are permitted.
- One 8.5 x 11" sheet of paper with only your own handwriting is allowed (one side only).
- No textbook or other resources.
- All other materials, books, and cell phones should be zipped in your backpack.
- Show all your work and provide complete explanations to receive credit.
- Time = 50 minutes

Problem	Estimated Time	Score	Possible
1	15 min		22
2	15 min		20
3	15 min		18
XC	5 min		4

Extra Space for your work below:

The normal boiling point (1 bar) of p-xylene is 411 K. Its enthalpy of vaporization is 42.3 kJ/mol at 313 K.

1. Draw a P-T phase diagram of p-xylene. Label the regions of vapor, liquid and solid. As is common with most compounds, the density of the solid is greater than that of the liquid. Make sure your solid-liquid line reflects that.

2. What is the triple point temperature of p-xylene? The vapor pressure of p-xylene at its triple point is 5.8×10^{-3} bar.

3. The critical pressure of p-xylene is 35 bar. Calculate its critical temperature.

4. The true triple point and critical point temperatures are 286 K and 617 K, respectively. Name at least two reasons why your calculations for the critical point were further off than the triple point.

5. A quantity of 3 mol of p-xylene is evaporated from a flask that initially contained a total of 8 mol p-xylene. How much heat needs to be supplied to the system to be kept at constant temperature of 313 K?

6. In another embodiment of the same experiment, 3 mol of p-xylene are evaporated adiabatically out of a quantity of 8 mol p-xylene initially at 313 K.

7. Draw out a thermodynamic cycle to calculate the final temperature of the system. You may assume that cooling is taking place first, followed by evaporation.

8. Calculate the final temperature of the system.

3 mol of butanol and 1 mol of water are mixed isothermally at 303 K.

1. How much entropy is generated upon mixing? Assume the mixing is ideal.

2. What is the change of Gibbs free energy upon mixing? Assume the mixing is ideal.

3. In reality, the mixing is not ideal, but exothermic with a $\Delta hmix = -2239 x_B x_W$. Calculate the partial molar enthalpy of mixing of water.

4. Calculate the partial molar Gibbs free energy of mixing of water, assuming that the entropic contributions are ideal.