 Name.....Code.....

Prince of Songkla University

Department of Chemical Engineering, Faculty of Engineering

Examination paper: Midterm Exam | Semester: 2/2009

Date: December 20, 2009 | Time: 13.30-16.30

Subject: 230–213 Chemical Engineering Thermodynamics | Room: R 300

ทุจริตในการสอบ โทษขั้นต่ำ คือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

Instruction:

- **Calculator, Dictionary, books, notes and class materials are allowed.**
- **No talking or discussing during taking this exam.**

Items	Full scores	Your scores
1	10	
2	20	
3	30	
4	15	
5	35	
Total	110	

ดร.สินินาฏ จงคง
ผู้ออกข้อสอบ

1. (10 points) Calculate Z and V for ethane at 50°C and 15 bar by the truncated virial equation with the following experimental values of virial coefficients:

$B = -156.7\ cm^3 mol^{-1}$ $C = 9{,}650\ cm^6 mol^{-1}$.

2. (20 points) Estimate the entropy change of vaporization of benzene at 50°C by using Eq. (6.72) $[\frac{dP^{sat}}{dt} = \frac{\Delta H^{lv}}{T\Delta V^{lv}}]$ with an estimated value of ΔV^{lv}. The vapor pressure of benzene is given by the equation:

$$\ln P^{sat}/kPa = 13.8858 - \frac{2{,}788.51}{t/°C + 220.79} \quad \text{and} \quad \frac{dP^{sat}}{dt} = 1.375 \ \frac{kPa}{K}.$$

3. (30 points) Propane gas at 1 bar and 35°C is compressed to the final state of 135 bar and 195°C. **Estimate** the molar volume (V) of the propane in the final state and the enthalpy (ΔH) and entropy change (ΔS) for the process. In its initial state, propane may be assumed an ideal gas.

   Given: $$C_p^{ig}/R = 1.213 + 28.785\times10^{-3}T - 8.824\times10^{-6}T^2$$

4. (15 points) A concentrated binary solution containing mostly species 2 (but $x_2 \neq 1$) is in equilibrium with a vapor phase containing both species 1 and 2. The pressure of this two-phase system is 1 bar; the temperature is 25°C. **Determine x_1 and y_1** from the following data: $\mathcal{H}_1$ = 200 bar P_2^{sat} = 0.10 bar.

5. (35 points) A binary system of species 1 and 2 consists of vapor and liquid phases in equilibrium at temperature T. The overall mole fraction of species 1 in the system is $z_1 = 0.65$. Assuming that Modified Raoult's law is appropriate to this system.

At temperature T,

- $\ln \gamma_1 = 0.67x_2^2$ and $\ln \gamma_2 = 0.67x_1^2$.
- $P_1^{sat} = 32.27$ kPa and $P_2^{sat} = 73.14$ kPa.

(a) Overall what range of pressures can this system exist as two phase at given T and z_1.

(b) For a liquid-phase mole fraction $x_1 = 0.75$, what is the pressure P and what molar fraction V of the system is vapor?

(c) Show whether or not the system exhibits an azeotrope.