

UNIVERSITY OF GHANA
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B.Sc ENGINEERING FIRST SEMESTER EXAMINATION: 2016/2017
SCHOOL OF ENGINEERING SCIENCES
FPEN 303: THERMODYNAMICS (2 Credits)

Answer FOUR questions:

TIME: TWO (2) HOURS

Question 1

- a) State the two main practical engineering problems that this course sought to address. Briefly discuss the basis for the solution of these problems in the context of equilibrium thermodynamics.
- (b) A ternary gas mixture contains 20 mol % A, 40 mol % B, and 40 mol % C. At a pressure of 80 atm and a temperature of 75°C, the fugacity coefficient of components A, B and C in this mixture are 0.4, 0.6 and 0.8 respectively. What is the fugacity of the mixture?
- c) Explain the basis of the equation you use in (b).

Question 2

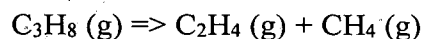
A mixture of the following composition:

	mol %
Ethane	25
Propane	35
n-butane	40

is brought to a condition of 40°F at a pressure P. If the molar fraction of liquid in the system is 0.45, what is pressure P (in bar) and what are the compositions of the liquid and vapour phases? Use the k-value (*DePriester*) chart given.

Question 3

For the cracking reaction



- The equilibrium conversion is negligible at 300 K, but becomes appreciable at temperatures above 500 K. For a pressure of 1 bar, determine the fractional conversion of propane at 600 K.

Compd. $\Delta H_{f,298}^0$ (J/mol) $\Delta G_{f,298}^0$ (J/mol)

$\text{C}_3\text{H}_8 (\text{g})$ -104,680 -24,290

$\text{C}_2\text{H}_4 (\text{g})$ 52,510 68,460

$\text{CH}_4 (\text{g})$ -74,520 -50,460

$R=8.314 \text{ J/mol.K}$

Question 4

For the system ethyl ethanoate (1)/n-heptane (2) at 450 K, assuming the validity of the modified Raoult's law

- Make a BUBL P calculation for $T=450 \text{ K}$, $x_1=0.06$
- Make a DEW P calculation for $T=450 \text{ K}$, $y_1=0.06$
- Determine if the system forms an azeotrope

Given the following data:

$$\ln \gamma_1 = 0.95x_2^2; \quad \ln \gamma_2 = 0.95x_1^2; \quad P_1^{\text{sat}} = 80.0 \text{ kPa}; \quad P_2^{\text{sat}} = 41.0 \text{ kPa}$$

Question 5

The following data was collected for ethanol-water mixture at 40°C.

Weight % Ethanol	Density (g/mL)
0	0.99220
10	0.97060
20	0.96130
30	0.94164
40	0.92070
50	0.89863
60	0.87070
70	0.85213
80	0.82622
90	0.80074
100	0.77240

Molar mass of ethanol and water are 46 g/mol and 18 g/mol, respectively.

- a) Plot the data above and determine the partial molar volumes from the graph at a mole fraction of 0.4.
- b) Using this values obtained from (a), confirm the additivity rule of partial molar quantities

