

University of Mumbai
Examinations Summer 2022
Program: **Chemical Engineering**
Curriculum Scheme: Rev2019
Examination: SE Semester IV

Course Code: CHC405 and Course Name: Chemical Engineering Thermodynamics II

Time: 2hour 30 minutes

Max. Marks: 80

DATE: 30/5/2022

QP CODE: 93794

Q1.	Choose the correct option for following questions. All the Questions are compulsory and carry equal marks
1.	For an ideal solution the partial vapour pressure of a component in solution is equal to the mole fraction of that component times its vapour pressure. Is the
Option A:	Henry's Law
Option B:	Dalton's Law
Option C:	Charles Law
Option D:	Raoult's Law
2.	Chemical potential is an _____ property.
Option A:	Extensive
Option B:	Intensive
Option C:	Path
Option D:	Reference
3.	Partial molar property
Option A:	is typically close to zero
Option B:	is always positive
Option C:	is always negative
Option D:	can be positive or negative
4.	Which refrigerant is widely used in refrigeration facilities of food as cooling of fresh vegetables, dairy products, meat and fish and similar process industries?
Option A:	sulphur dioxide
Option B:	ethyl chloride
Option C:	Propane
Option D:	Ammonia
5.	How does the UNIQUAC model help?
Option A:	It helps to place calculations of activity coefficients on practical basis
Option B:	It helps to place calculations of activity coefficients on theoretical basis
Option C:	It helps to place calculations of activity coefficients from graph
Option D:	It helps to provide a easier way to place calculations
6.	$(G^E/RT) = A x_1 x_2$ is the expression for
Option A:	Van Laar equation
Option B:	Two suffix Margules equation
Option C:	Wilson equation
Option D:	NRTL equation

7.	In a refrigeration system, the expansion device is connected between the
Option A:	Compressor and condenser
Option B:	Condenser and absorber
Option C:	Condenser and evaporator
Option D:	Evaporator and compressor
8.	In a binary system at constant temperature and pressure, the equation used to test thermodynamic consistency of VLE data is
Option A:	Lewis – Randall rule
Option B:	Henry’s Law
Option C:	Gibbs – Duhem equation
Option D:	Gibbs – Helmholtz equation
9.	Estimate the degrees of freedom for a reacting system (reaction given below) where the number of independent reaction is 1. $N_2(g) + 3H_2(g) = 2NH_3(g)$
Option A:	0
Option B:	2
Option C:	3
Option D:	1
10.	Equilibrium constant at 298K for a reaction with $\Delta G_0 = -4 \text{ KJ/mol}$ is:
Option A:	4.4
Option B:	5.025
Option C:	7.8
Option D:	10.25

Q2 (20 Marks)	Solve any Four out of Six	5 marks each
A	Explain Concept of Phase Equilibria	
B	State Raoult’s law. Show that it is simplified form of Lewis Randall Rule	
C	Explain Properties of Refrigerant.	
D	Derive the relationship between the mole fraction of the components taking part in the reaction and the extent of reaction.	
E	Explain Partial Molar Properties.	
F	Explain Fugacity and activity coefficients	

Q3 (20 Marks)	Solve any Two Questions out of Three	10 marks each
A	A gaseous mixture containing 25% CO, 55% H ₂ and 20 % inert gas is sent to a reaction chamber for methanol synthesis. The following reaction occurs at 625 K and 300 bar	

	$\text{CO (g)} + 2 \text{H}_2 \text{(g)} \rightarrow \text{CH}_3\text{OH (g)}$ Assuming that the gas mixture behaves as an ideal solution calculate the percent conversion of CO given that $K_f = 5 \times 10^{-5}$ and $K_\phi = 0.35$
B	The enthalpy of a binary liquid mixture containing components 1 and 2 at 298 K and 1 bar is given by $H = 400 x_1 + 600 x_2 + x_1 x_2 (40 x_1 + 20 x_2)$ where H is in J/mol. Obtain expression for partial molar enthalpies of H_1 and H_2 in terms of x_1 and the numerical values of the pure component enthalpies H_1 and H_2 . Determine the partial molar enthalpies of component 1 and 2 at infinite dilution.
C	At a pressure of 101.3 kPa, ethyl acetate (1) and ethyl alcohol(2) form an azeotrope containing 53.90 mole % ethyl acetate at 345 K i) Determine the van Laar constants ii) Determine the composition of the vapour in equilibrium with a liquid of composition 60 mole % alcohol and 40 % acetate and boiling at a temperature of 329.5 K. Data : The vapour pressure of ethyl acetate and ethyl alcohol at 345 K are 84.77 kPa and 78.24 kPa The vapour pressure of ethyl acetate and ethyl alcohol at 329.5 K are 47.98 kPa and 39.72 kPa

Q4. (20 Marks)	Solve any Two Questions out of Three	10 marks each
A	For a system excess free energy is given by the relation $\frac{G^E}{RT} = (1.42 x_1 + 0.59 x_2) x_1 x_2$ Find out the expression for $\ln \gamma_1$ and $\ln \gamma_2$ and Do the system satisfy Gibbs Duhem equation ?	
B	The vapour compression unit using Freon – 12 operated between 151 kPa and 746 kPa. The fluid leaving the evaporator is saturated vapor and leaves the condenser at 303 K. $C_{pv} = 0.74 \text{ kJ/kg K}$ Calculate: 1.Refrigeration effect. 2.Power required. 3.Coefficient of performance.	

	Ps , kPa	Ts , K	Vs , m ³ /kg	H _l kJ/kg	H _v kJ/kg	Entropy of vapour (kJ/kg.K)
	151	253	0.1093	17.81	179.63	0.7123
	746.6	303	0.0236	64.77	201.10	0.6703
C	<p>Show that the chemical potential of a component i in liquid equal to chemical potential of the same component in vapor when the two phases are in equilibrium</p> <p>i.e $\mu_i^L = \mu_i^V$</p>					