Exam IV

CH 353 Sumer 2007

Vanden Bout

Name: KEY

You can use anything to answer the following except someone else.
Carefully read all the problems. The exam should have 4 questions on 6 pages. The first page has potentially useful information. The last page is for extra writing space.

R = 8.314 J K^{-1} mol^{-1} R = 8.314×10^{-2} L bar K^{-1} mol^{-1} R = 8.206×10^{-2} L atm mol^{-1} K^{-1}

1 atm = 1.01325 bar T/K = T/°C + 273.15 1 atm-L = 101.325 J 1 bar-L = 100 J

g = 9.8 m s^{-2} $\Pi = \rho g h$

$$\frac{dP}{dT} = \frac{\Delta S}{\Delta V} = \frac{\Delta H}{T\Delta V} \qquad \ln\left(\frac{P_2}{P_1}\right) = \frac{-\Delta H}{R}\left[\frac{1}{T_2} - \frac{1}{T_1}\right]$$

$$\Delta T = KX_B \quad K \equiv \frac{RT_b^{*2}}{\Delta_{VAP}H} \qquad \Delta T = K'X_B \quad K' \equiv \frac{RT_m^{*2}}{\Delta_{FUS}H}$$

$$\Pi = \frac{n_B}{V}RT = [B]RT$$

$$\left(\frac{\partial \mu}{\partial P}\right)_T = V_M \qquad \left(\frac{\partial \mu}{\partial T}\right)_P = -S_M$$

Please sign at the bottom to certify that you have worked on your own.
I certify that I have worked the following exam without the help of others, and that the work I am turning in is my own.

Signed: --

Signature Date

1. True/False Circle either T or F for each statement (10 points each)

T (F) It is not possible for a pure substance to have two different solid phases.

(T) F For an ideal mixture in a liquid-vapor equilibrium, $Y_A = \frac{X_A P_A^*}{P}$ $YA = \frac{P_A}{P}$

T (F) For a mixture of two volatile liquids A & B, if the $P_A^* > P_B^*$ there will always be more moles of A than moles of B in the vapor phase. $Y_A > Z_A$ NOT $Y_A > Y_B$

(T) F For a mixture of two liquids A& B, if the intermolecular interactions between A-B are lower in energy (more attractive) than A-A, the Henry's Law constant for A in B will be lower than the pure vapor pressure of A.

T (F) If two liquids are immiscible they will phase separate into two pure liquid phases.

2A. (25 points)

A real mixture of CS_2 and acetone with a liquid mole fraction that is 0.675 CS_2, has a P_{CS2} = 446.5 Torr and $P_{Acetone}$ = 215 Torr.

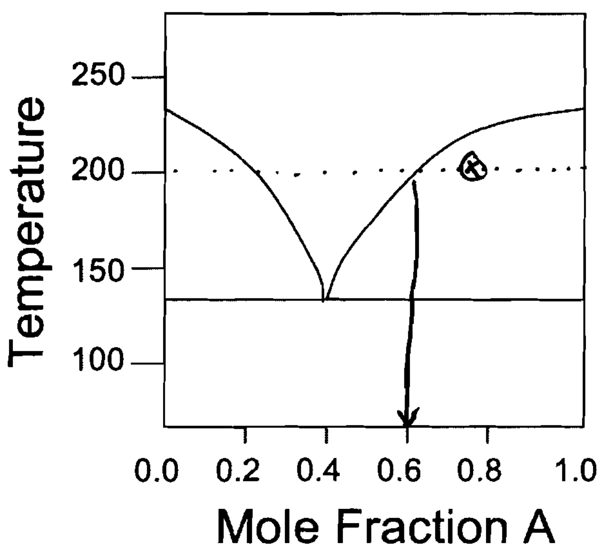
Is this mixture and azeotrope? Why or why not.

what is $y_{CS_2} = \frac{P_{CS_2}}{P_{TOTAL}} = \frac{446.5}{446.5+215} = 0.67$

$X_{CS_2} = y_{CS_2}$ ∴ azeotrope

2B. (25 points)

The phase diagram below shows phases of a solid-liquid region for two compounds A & B. If the overall mole fraction of component A is 0.75, what phases are present 200°C, what are their compositions, and which phase has the greatest number of moles?



pure A solid +
liq $X_A = 0.6$

more moles liq
X_A closer to Z_A
than pure A solid.

3. (50 Points)

An ideal mixture of toluene of benzene contains 6 moles of benzene and 4 moles of toluene at 25°C. The vapor pressure of pure benzene at 25°C is 96 Torr, the vapor pressure of pure toluene is 29 Torr. Initially you have your mixture at a pressure of 760 Torr and the mixture is only liquid. Then you slowly lower the pressure until the total pressure is 60 Torr.

What are the compositions of the liquid phase and vapor phase?
How many moles of liquid and vapor are there?
(note: it is possible the system is all liquid or all vapor)

$Z_A = 0.6$

$P = P_A + P_B$

A Benzene
B Toluene

$P = X_A P_A^* + (1 - X_A) P_B^*$

$P = X_A P_A^* + P_B - X_A P_B^*$

$X_A = \frac{P - P_B^*}{(P_A^* - P_B^*)} = \frac{60 - 29}{96 - 29} = \frac{31}{67} = 0.463$

$Y_A = \frac{P_A}{P} = \frac{X_A P_A^*}{P} = \frac{.463(96)}{60} = 0.74$

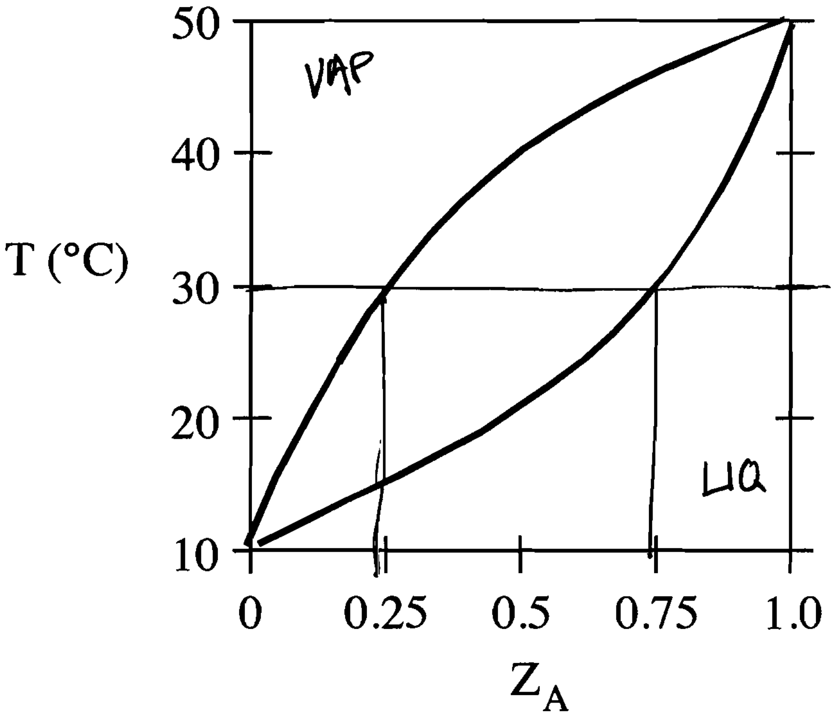
$n_{liq}(.6 - .463) = n_{VAP}(.74 - .6)$

$\frac{n_{liq}}{n_{VAP}} = 1.02$

$n_{liq} + n_{VAP} = 10 \qquad 1.02\, n_{VAP} + n_{VAP} = 10$

$n_{VAP} = 4.95 \qquad n_{liq} = 5.05$

4. (50 points)



The temperature composition diagram for binary mixture of two compounds A & B at a pressure of 1 bar is given above. Assume the vapors are ideal gases and the mixture is an ideal mixture.

What is the boiling temperature of pure A? 50°C

What is the vapor pressure of pure compound A at 30°C? $Y_A = .25$ $X_A = .75$

What is the vapor pressure of pure compound B at 30°C?

What is the enthalpy of vaporization of pure A?

$P_A = Y_A P = (.25)(1) = .25$ bar

$.25 = .75 P_A^* \Rightarrow 0.333$ bar $= P_A^*$

$P_B = (.75)(1) = .75$ bar

$P_B^* = \frac{.75}{.25} = 3$ bar

$\ln\left(\frac{1}{.333}\right) = \frac{-\Delta H}{8.314}\left[\frac{1}{323}\right.$

ΔH = 44.74 kJ

$\ln\left(\frac{P_2}{P_1}\right) = \frac{-\Delta H}{R}\left[\frac{1}{T_2} - \frac{1}{T_1}\right]$