# Quiz IV

CH 353 Sumer 2008

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.

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

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

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

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

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

$$P_A = X_A P_A^* \qquad P_A = Y_A P \qquad P_A = X_A K$$

$$F = C - P + 2$$

**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 For an ideal mixture, the enthalpy of mixing is always zero. all interactions =

T (F) In a mixture with two phases in equilibrium, the phase with the greater number of moles has the lower chemical potential.

$\mu_A = \mu_B$

T (F) For a mixture of two volatile liquids A & B, if the $P_A^* > P_B^*$ there will always be more moles of B than moles of A in the gas phase.

$Y_B > Y_A$ NOT always true

(T) F The triple point of a solution of 0.1 M NaCl in water will occur at only on temperature and pressure.

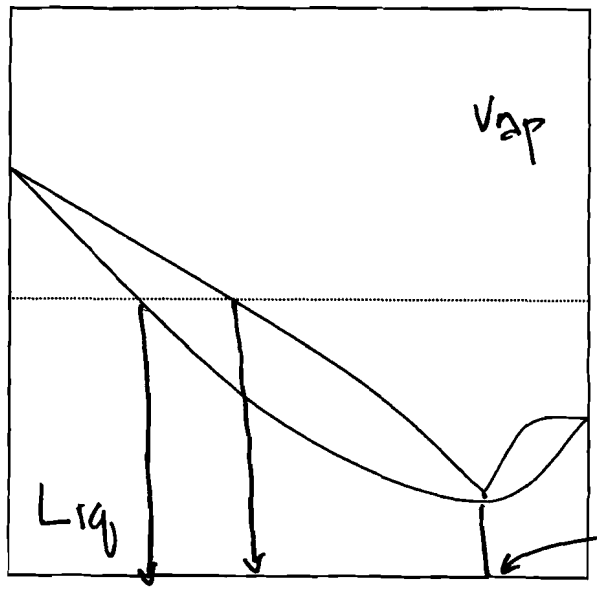
Yes . fixed conc.

T (F) It is not possible to completely mix two real liquids into a single phase.

Yes it is possible

/

2A. (25 points)




This phase diagram shows a mixture of two volatile liquids at various temperatures.

Does the mixture have an azeotrope? If so at what composition?

What is the composition of the liquid and vapor phases at the temperature marked with the dotted line?

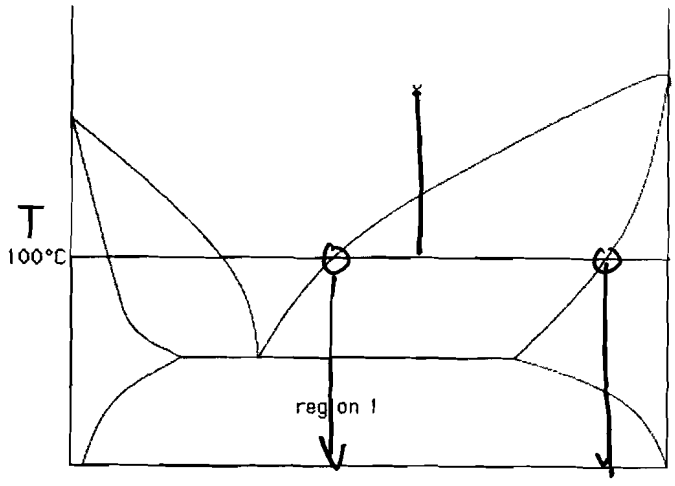
(You will need to estimate numbers on the composition axis)

AZEOTROPE $X_A = Y_A = 0.85$

$X_A$ $Y_A$ @ 100°C $X_A \approx 0.25$

$Y_A \approx 0.40$

2B. (25 points)




This phase diagram shows a mixture of two compounds at various temperatures. Given that region 1 is a 2 phase region with solids of different compositions, answer the following.

If a mixture with a composition marked by the x on the diagram were cooled to 100° C what would be the composition(s) and phase(s) of the materials at 100°C. If there are two phases, which would have the greater number of moles. (You will need to estimate numbers on the composition axis)

$X_{liq}$ $X_{A,sol}$

Liq $X_A = 0.4$

solid $X_A = 0.95$

$n_{liq} > n_{sol}$

3A. (25 Points)

A mixture of contains one mole of liquid A and three moles of liquid B in a liquid-vapor equilibrium at 50°C. The vapor pressure of pure A at 50°C is 200 Torr and the vapor pressure of pure B at 50°C is 400 Torr. What is the total pressure of the mixture and what is the mole fraction of A in the gas phase?

$$X_A = \frac{1}{1+3} = 0.25$$

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

$$P = .25(200) + .75(400) = 350 \text{ Torr}$$

$$Y_A = \frac{P_A}{P} = \frac{.25(200)}{350} = 0.143$$

3B. (25 points)

A mixture contains a total of 2 moles of liquid A and 8 moles of liquid B. The vapor pressure of pure A is 200 Torr at 25°C, and the vapor pressure of pure B is 500 Torr at 25°C. If the total pressure is 450 Torr, what is the state of the system? (all liquid, all vapor, liquid-vapor equilibrium?) Justify your answer mathematically.

$$Z_A = \frac{2}{2+8} = 10$$

$$P = P_A + P_B = 450$$

$$450 = X_A P_A^* + (1 - X_A) P_B^*$$

$$450 = X_A(200) + (1 - X_A)500$$

$$X_A = 0.167$$

$$Y_A = \frac{P_A}{P} = \frac{.167(200)}{450} = 0.074$$

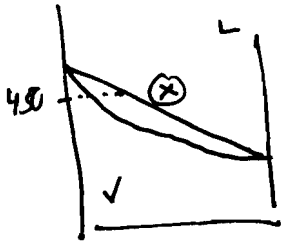
$\therefore$ All liquid

@ equil $X_A = .167$

$Y_A = .074$

$Z_A > X_A$

can't be in eq



4. (50 points)
At a particular temperature the vapor pressure of pure $CS_2$ is 520 Torr and the vapor pressure of pure acetone is 350 Torr. The Henry's law constant for $CS_2$ in acetone is 1900 Torr and the Henry's Law constant for acetone in $CS_2$ is 2400 Torr.

Assuming you have a solution that has a liquid mole fraction 0.95 $CS_2$ in which the solvent follows Raoult's Law and the solute follows Henry's Law

What is the total vapor pressure of acetone and $CS_2$ above the solution?
(you'll need to find the vapor pressure of acetone and the vapor pressure of $CS_2$)

$P_{CS} = .95 P^*_{CS} = .95(520) = 494$ Torr

$P_{Ac} = 0.05 K_{Ac/CS_2} = .05(2400) = 120$ Torr

$P = 494 + 120$
$= 614$ Torr

What is the composition of the vapor phase?

$$Y_{CS_2} = \frac{P_{CS_2}}{P} = \frac{494}{614} = 0.804$$

Based on the pure vapor pressures and the Henry's law constants explain whether you think the acetone molecules have a stronger attraction for themselves or for $CS_2$

Ac-Ac much strong $K >> P^*_{Ac}$

Is this mixture and azeotrope? Why or why not.

NO $X_{CS_2} \neq Y_{CS_2}$