King Saud University

College of science

Chemistry Department

Name: ……
ID:……

CHEM336 **Final exam** **3rd Trimester** **2022/2023**

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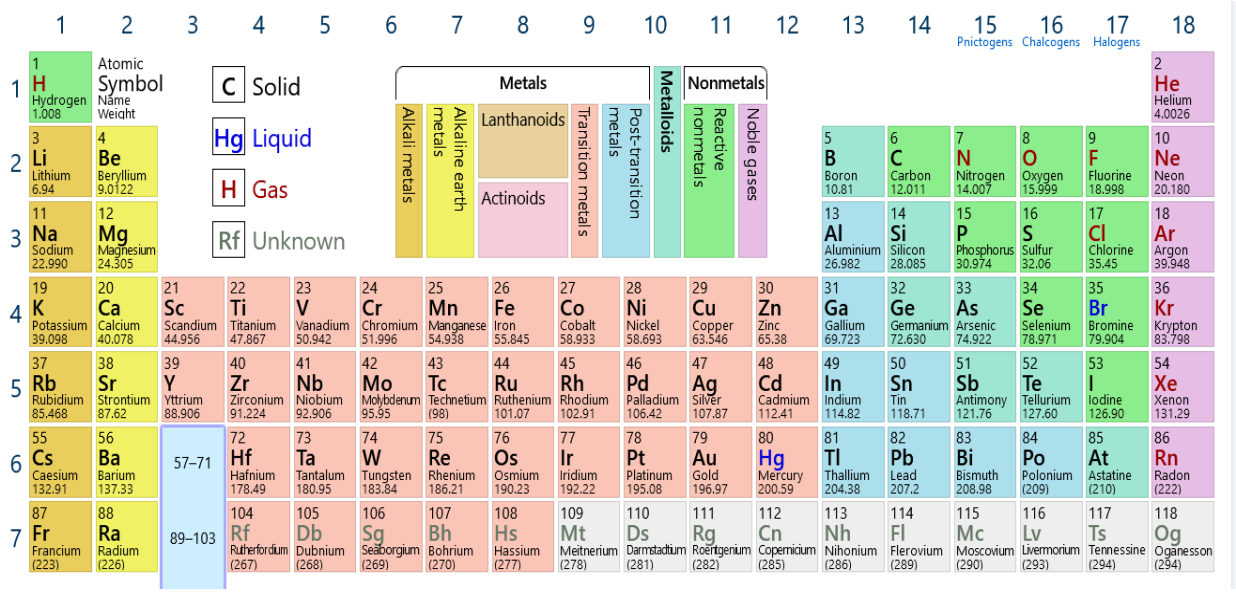


R = 8.314 J/mol.K = 0.082 L.Atm/mol.K

Questions

Q_1(10 marks). Which of the following statement is true and which one is false?

a) The excess functions give us the measure of the amount of deviation from ideality (true)

b) A line joining two points representing phases in equilibrium is called a tie line (true)

c) An alloy of two metals is a two-phase system (P = 1) if the metals are immiscible. (False)

d) A simple distillation is used to separate volatile liquids (false)

e) ΔS for mixing ideal gases is negative. (false)

f) Solutions that obey Raoult's law are called ideal solutions (true)

g) Negative deviation from Raoult's law occurs when the attraction force between A-B pairs is stronger than between A-A and B-B pairs (true)

h) In Ideal Dilute Solution, solute obeys Raoult's Law and solvent obeys Henry's Law (false)

i) The boiling point of an azeotropic mixture may be higher or lower than that of any of its components (True)

j) The solubility constant (K_S) for Na_2SO_4 (solid) + $H_2O \rightarrow Na_2SO_4$ (aq) $\rightarrow$ $2Na^+ + SO_4^{2-}$ is $2S^3$. (False)

Q_2 (3 marks) (choose only one answer from the answers given below)

1) The movement of water through a semi-permeable membrane from dilute side to concentrated side is called:
   a) Diffusion
   b) Solubility
   c) Depression of vapour pressure
   d) Osmosis

2) All colligative properties depend on:
   a) the number of the solute molecules
   b) the nature of the solute molecules
   c) a and b
   d) the number of the solvent molecules

3) For mixing ideal gases, indicate which of the following answers is correct
   a) $\Delta_{mix}H = 0$, $\Delta S_{mix} = 0$, and $\Delta G_{mix} < 0$
   b) $\Delta_{mix}H = 0$, $\Delta S_{mix} > 0$, and $\Delta G_{mix} < 0$
   c) $\Delta_{mix}H > 0$, $\Delta S_{mix} > 0$, and $\Delta G_{mix} < 0$
   d) $\Delta_{mix}H = 0$, $\Delta S_{mix} < 0$, and $\Delta G_{mix} > 0$

Q_3 (4 Marks).

In the following diagram for Liquid–liquid phase diagrams, Critical

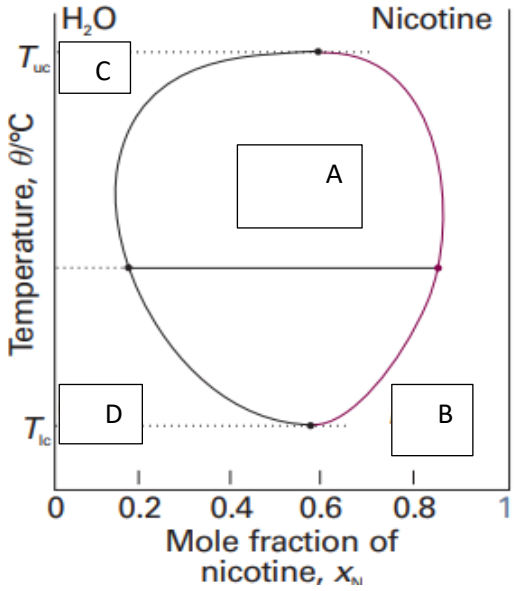
In the following diagram for Liquid–liquid phase diagrams, Critical solution temperature. Where (A), (B), (C) and (D) represent:

a) one phase, 2 phase, upper critical solution temperature and Lower critical solution temperature respectively

b) 2 phases, one phase, upper critical solution temperature and Lower critical solution temperature respectively

c) 2 phases, one phase, Lower critical solution temperature and upper critical solution temperature respectively

d) 2 phases, 2 phases, upper critical solution temperature and upper critical solution temperature respectively



Q4 (1 mark). The isotropic point of a binary liquid solution is when:

A) At a certain composition the two components has the same vaporization and boiling temperatures
B) At a certain composition we can separate the components of the mixture
C) At a certain temperature and composition the mixture forms two different phases
D) Two phases form only one miscible phase

Q5(1 mark). During the distillation of binary miscible mixture:

A) The temperature of vaporization of each component remains constant during its vaporization
B) The temperature of vaporization vary with the concentration of each component
C) The vaporization and the boiling temperatures remains the same during the distillation process at any composition
D) The separation of the components of a liquid mixture is possible when the difference between their vaporization temperature is large as possible
E) The separation of the components of a liquid mixture is possible when no difference exist between their vaporization

Q_6. (1 mark) A eutectic point is:

A) At a certain composition of a binary solid liquid mixture the two components has the same vaporization temperature.
B) At a certain composition of a binary solid liquid mixture the two components has the same boling temperature.
C) At a certain composition of a binary solid liquid mixture the two components has the same melting temperature.
D) At a certain composition each component has two melting temperatures
E) At a certain temperature each component has two compositions

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Exercises

Exercise 1(2 marks). A solution is prepared from 4.60 g of ethanol and 11.60 g of acetone at 25 ^{o}C. If the saturated pressure of ethanol is 1.634 Atm and the pressure of ethanol in this solution was 0.813 atm. The activity coefficient of ethanol (γ) is:

A) 1.00 B) 1.49 C) 0.87 D) 2.3

This solution is:

A) Real B) Ideal C) homogeneous D) heterogeneous

Exercise 2 (1 mark). The enthalpy of an ideal mixture (ΔH_M) in joule composed of 4.6 g of ethanol and 1.8 g of water at 25 ^{o}C is:

A) 342.45 B) 532.22 C) 0 D) 193.05

Exercise 3 (1 marks). The entropy of an ideal mixture (ΔS_M) in joule composed of 4.6 g of ethanol and 1.8 g of water at 25 ^{o}C is:

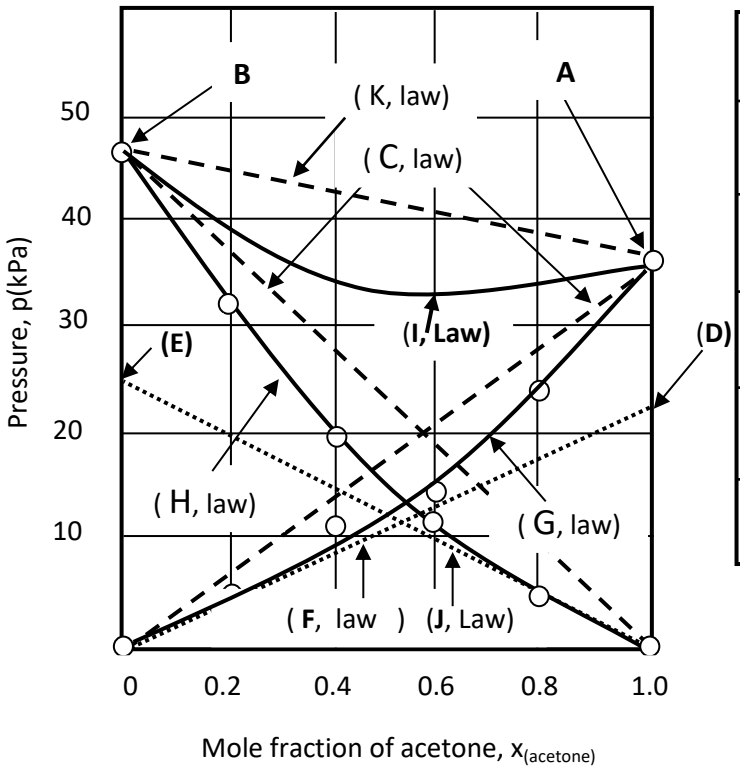
A) 342.45 B) 532.22 C) 0 D) 0.765

Exercise 6 (3 marks). The vapor pressures of each component in a mixture of acetone and formaldehyde were measured at 25^{o}C and the results obtained are illustrated in the following diagrams. Attribute the corresponding equation or name below in the different positions in the Table.

Henry's law; Raoult's law (ideal solution); Raoult's law (real solution); K(acetone); K(formaldehyde) ; P^o (acetone); P^o(formaldehyde).

A: acetone and B: formaldehyde

1) $P_{Form} = x_{Form} \cdot P^o_{Form}$; 2) $P_{Form} = a_{Form} \cdot P^o_{Form}$; 3) $P_{Acet} = a_{Acet} \cdot P^o_{Acet}$; 4) $P_{Ac} = x_{Acet} \cdot P^o_{Acet}$; 5) $P_{Acet} = x_{Acet} \cdot K_{Acet}$; 6) $P_{Form} = x_{Form} \cdot K_{Form}$; 7) K_{Acet} ; 8) K_{Form}, 9) P^o_{Acet} ; 10) P^o_{Form}; 11) P_T(real); 12) P_T(ideal)



A	9	G	3
B	10	K	12
C	1,4	H	2
D	7	I	11
E	8	J	6
F	5		

Exercise 7 (1 mark). A sample of 2.5 liter of carbon dioxide (CO_2) at 3.0 atm and 25 ^oC is absorbed by water to form 250 ml of solution at these conditions. If this gas is considered as perfect, the molar concentration of CO_2 in this solution formed is:

A) 3.43×10^{-1} B) 2.0×10^{-2} C) 3.07×10^{-1} D) 1.228

Exercise 8(1 mark). The molar volume of acetic acid (CH_3COOH) given the density of this compound 1.05 g/mL is:

A) 22.4 B) 60 C) 57.14 D) 0.0175

Exercise 9(1mark). The total volume of 150 g of water/ethanol solution at 25°C obeys to the following expression:

$$V_T = 23.24 + 42.1\ n + 34.43\ n^2$$

where n is the molar number of ethanol. When n = 0.230, the molar volume of ethanol in this solution is:

A) 34.74 B) 57.94 C) 26.33 D) 2.82

Exercise 10 (1 mark). The total free enthalpy of toluene/cyclohexane mixture (ΔG_M) is expressed by the following equation:

$$\Delta G_M = 43.32 + 6.32\ n + 27.08\ n^2$$

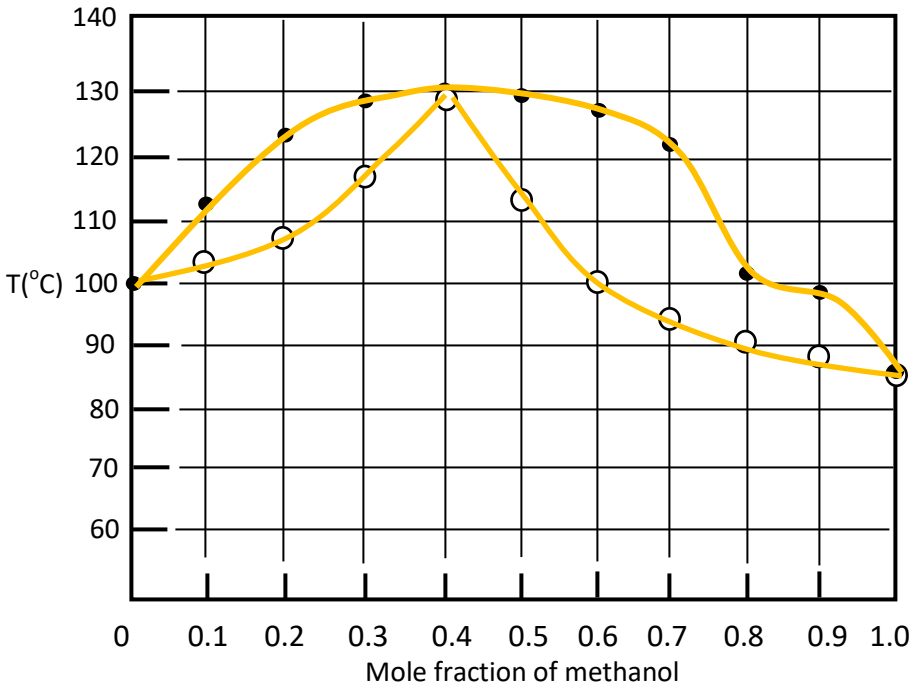
n is the mole number of toluene. If the mole number of toluene is 2.22, the chemical potential of toluene ($\mu_{Toluene}$) is:

A) 126.56 B) 194.36 C) 66.44 D) 43.32

Exercise 11(4 marks).The distillation of a binary liquid volatile mixture containing toluene and methanol of different compositions obtained at 1 atm gave the results grouped in the following Table:

X_{Tol}	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
T_{Boil}(C)	100	113	123	128	130	129	127	122	101	99	85
T_{Vap}(C)	100	103	107	117	130	113	100	94	90	88	85

A) Draw the curves corresponding to the boiling and vaporization of this binary system.



B) Indicate on this diagram the different zones of the states (liquid, vapor, liquid + vapor, Azeotrope)

C) For 0.4 mole fraction in methanol, what is the boiling temperature of the mixture and the vaporization temperature of this component in the mixture deducted from the diagram resulted?

Boiling temperature (°C)	130
Vaporization temperature (oC)	130

D) At a composition of 0.8 in methanol and at temperature of 100 °C, indicate from the diagram obtained whether the mixture is in liquid, vapor or Liquid-vapor state

Liquid	Vapor	Liquid Vapor

E) At a composition of 0.3 in methanol and at temperature of ~~110 °C~~ 120 °C, indicate from the diagram obtained whether the mixture is in liquid, vapor or Liquid-vapor state

Liquid	Vapor	Liquid Vapor

F) At a composition of 0.6 in methanol and at temperature of ~~90 °C~~ 135 °C, indicate from the diagram obtained whether the mixture is in liquid, vapor or Liquid-vapor state.

Liquid	Vapor	Liquid Vapor

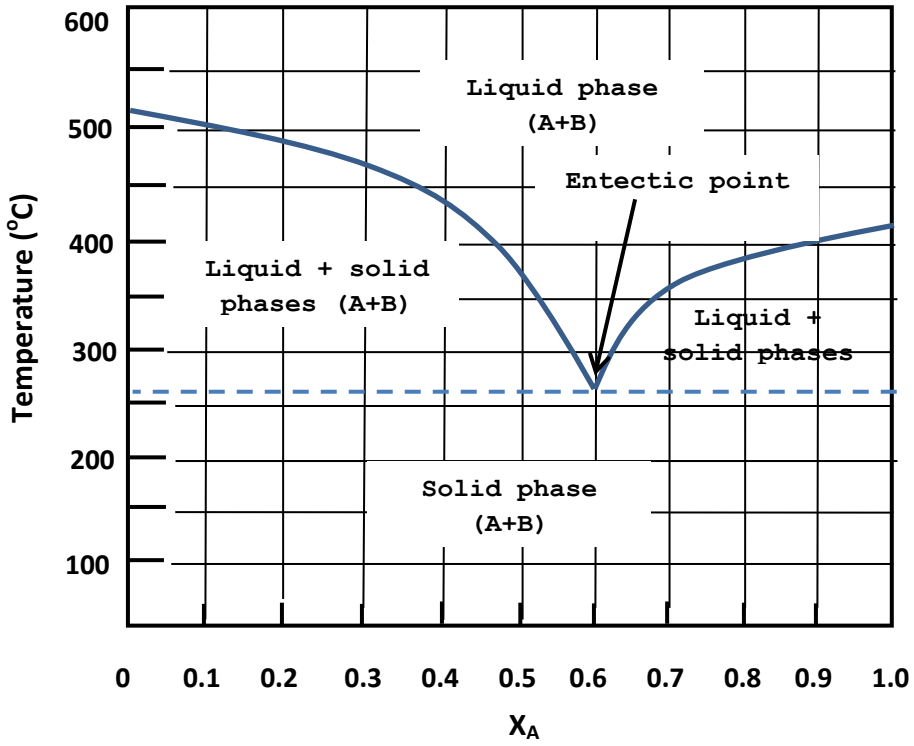
G) Indicate if possible to separate the components of this mixture at temperature of 90 °C when the mol fraction in methanol is 0.3.

No. because the two components are in their liquid phase

H) Indicate if possible to separate the components of this mixture when the mol fraction in methanol is 0.6 and temperature of 110 °C.

Yes. Because the two components are in two different phases

Exercise 12 (6 marks). The diagram of solid-liquid binary diagram of A/B mixture a different composition is giving in the following figure:



A) Indicate the different zones of the state of the A/B mixture (Liquid, solid, Eutectic and Solid-liquid) on the diagram.

B) What are the melting temperature of A and B

Melting temperature of A: …427 °C……..

Melting temperature of B:…525 °C……..

B) What is the temperature and the composition(mole fraction) of A at the Entectic point?

Eutectic temperature: ……260 °C……..

Eutectic composition:……0.6……

C) What is the state of this mixture when the mol fraction of A is 0.3 and the temperature 400 °C? State: ……Liquid-Solid…….

D) What is the state of this mixture when the mole fraction of A is 0.90 at a temperature of 450 °C? State:……Liquid……

E) Can a mixture containing 0.3 mol of A and 0.7 mol of B be separated at a temperature of 550 °C.

Answer: No. Because in this point the two component are in their liquid phase……

Exercise 16(3 marks). An immiscible binary system containing A and B components at ambiente temperature (25oC and 1 atm). The limit temperature of separation of this mixture versus the mole fraction of A is indicated in the following table

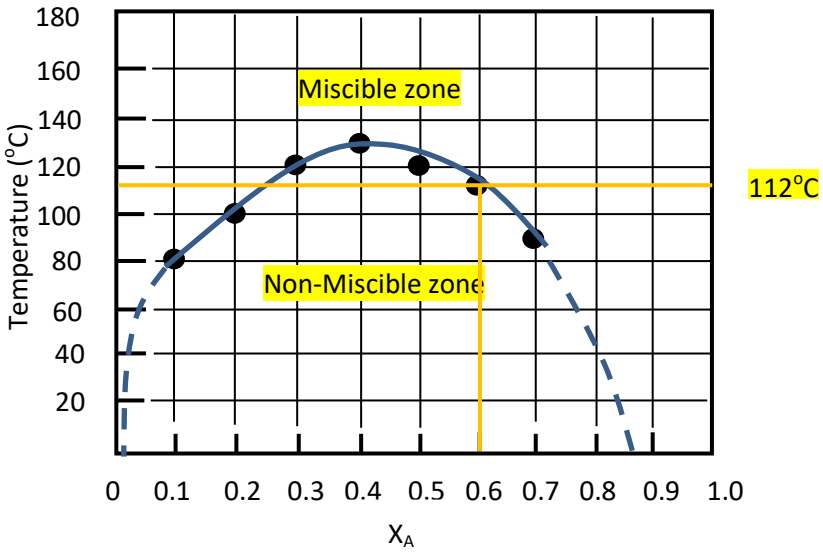
X_A	0.1	0.2	0.3	0.5	0.7	0.8	0.9
T (°C)	80	100	120	125	120	110	70

A) Draw the curves corresponding to the diagram liquid-liquid.

B) Indicate on the diagram the different zones (Miscible, immiscible on the phase diagram

C) What is the temperature limit to make an immiscible mixture in a miscible mixture if the mole fraction of A is 0.60 mole ?

Temperature (°C)	112



Exercise 17(4 marks). A solution containing 8 mol of sodium chloride and one kg of water is an 8 molal solution of sodium chloride. The molality of the sodium ion in the solution is 3. The molar mass of water is 18.02 gram/mol. The molality of the chloride ion in the solution is also 5.

A) What is the mole fraction of the sodium ion?
0.04725

B) What is the mole fraction of the chlorid ion?
0.07875

C) What is the mole fraction of water?
0.87400

D) What are the molarities of the sodium ion,the chloride ion and of sodium chloride in the solution if the density was 1.1942 kg/liter at 25 °C and 1 bar.
V of solution is 1.04357 L
C_{Na^+}= 2.8747 mol/litter
C_{Cl^-} = 4.79123 mol/litter
C_{NaCl} = 7.6660 mol/litter