Benha University

Model answer

Shoubra Faculty of Engineering

Department of mathematics and Engineering physics
First term exam 2019-2020
Preparatory year

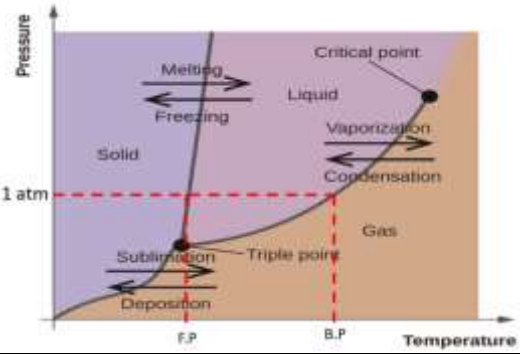
Date: 11/1/2020
Duration: 3 hours
General chemistry/EMP013

- Illustrate your answers with sketches when necessary
- The exam consists of one sheet (two pages)
- No. of questions: 4
- Total Mark: 90 Marks

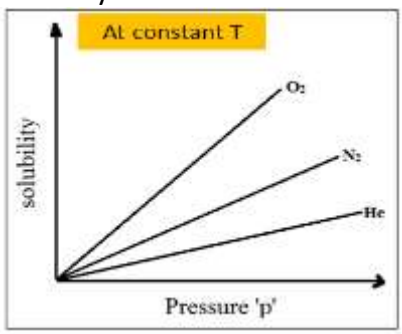
Question (3) [23 marks]

(3a) Draw the suitable graph that represents each of the following: answer 3 points only **[6 marks]**

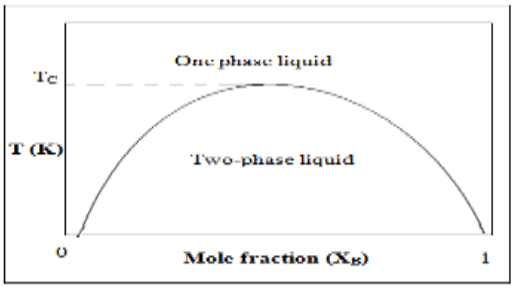
Phase diagram of a matter :



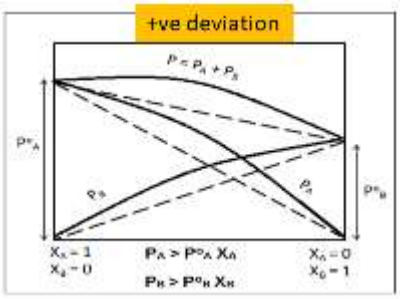
Hennery's law:



Partially miscible liquids:



Raoul's for acetone/ethanol solution:



(3b) What is distillation? How can we separate two miscible liquids based on this principle? **[3 marks]**

- Distillation: is a process by which a mixture of liquids is separated into its components. Two ways:
  1- Simple distillation: by heating, the most volatile liquid comes out first (wide different B.P > 100°C).
  2- Fractional distillation: different B.P < 100°C. Applied in industry by using fractional distillation column.

(3c) Tabulate the chemical composition of cement and write short note on one of its pollution. **[6 marks]**

Oxide	CaO	SiO_2	Al_2O_3	Fe_2O_3	MgO	$CaSO_4$
abbreviation	C	S	A	F	M	Gypsum
%	60-65	19-25	3-8	1-5	0-5	1-4

Emissions to air: 5–7% of the total CO_2 emission. It can be:
Directly: during heating of limestone.
Indirectly: during burning of fossil fuels to heat the kiln Other emissions such as NOx - SO_2 - volatile organic compounds, HF - HCl - CO. The ways to reduce these emissions:

1- By replacing fossil fuels used in kiln by natural gas.
2- By Capturing CO_2 emissions through: - Carbon capture and storage" (CCS) units - Accelerated carbonation method by passing CO_2 through $Ca(OH)_2$ solution to form $CaCO_3$.

(3d) Answer <u>4 points only</u> of the following: **[8 marks (2 marks for each point)]**

1) Predict whether each solute of the following forms solution with water or not?

CH_3OH – $C_{10}H_8$ – $C_6H_{12}O_6$ – $CaCl_2$

Based on the rule "like dissolves like, and since H_2O is polar , so only polar or ionic solids will dissolve in water, thus: CH_3OH is polar so it is miscible with water – $C_{10}H_8$ is nonpolar so it is immiscible with water
$C_6H_{12}O_6$ is polar so it is soluble in water – $CaCl_2$ is ionic and it is soluble in water.

Calculate:

2) The mass of methanol (MW 32.0 g/mol) in 0.5 L aqueous solution that has **(π)** of 5.08 atm at 37 °C.

Osmotic pressure, $\pi = M . R . T$ since $\pi =$ of 5.08 atm, R = 0.082, T = 37+273 = 310 K
$\pi = 5.08 = M \times 0.082 \times 310$ thus, M = 0.2 mol/L
M = n (solute)/ V of solution thus, 0.2 = n/0.5 so n = 0.1 mole
n(solute) = mass/molar mass, thus 0.1 = mass/32 thus, mass = **<u>3.2 g</u>**

3) The pressure at which the solubility of N_2 gas in water is twice its value at 1.5 atm and 25 °C.

$m_1 / m_2 = P_1/P_2$ since $m_2 = 2\ m_1 = P_1 = 1.5$ atm , $P_2 = ?$ thus, **<u>$P_2 = 3.0$ atm</u>**

4) The vapor pressure of an ideal solution contains equal moles of benzene and toluene at 25 °C.

(P^o benzene = 95.1 mmHg, P^o toluene = 28.4 mmHg at 25 °C)

Let benzene = A, and toluene = B , Solution obeys Raoult's law, so , **$P_t = X_A . P^o_A + X_B . P^o_B$**
P^o_A and P^o_B are the vapor pressure of the pure solvents, X_A, X_B are mole fractions of A and B.
n of benzene = n of toluene = 1 so, $X_A = X_B = 0.5$, $P_{(soln)} = 0.5 \times 95.1 + 0.5 \times 28.4 =$ **<u>61.8 mmHg</u>**

5) The freezing point of a solution contains 0.5 mole $CaCl_2$ in 500 g water (K_f of water is -1.86 °C molal).

$\Delta T_f = k_f . m . i$ since $k_f = -1.86$, m = molality = 0.5/0.5 = 1.0 molal, i = 3 ions

So, $\Delta T_f = -1.86 \times 1.0 \times 3 = -5.58$ °C, So F.P (solution) = ΔT_f + F.P (water) = -5.58 + 0.0 **<u>= -5.58 °C</u>**

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