Ministry of Higher Education
The Higher Institute of Engineering and Technology in New Damietta
Course title: General Chemistry
Course code: CHE 101
Semester: Summer Semester

Department: Basic Science
Level: one
Time allowed: 60 min
Date: 29-7-2018 Day: Sunday
Full Mark: 20
No. of exam pages:1

Model answer of midterm exam of summer course July 2018

Question 1 (6 marks, 2 marks for each point)

Compare between each of the following

a. Intensive and extensive properties with examples of each.
b. Effect of temperature on solubility of solid in liquid and solubility gas in liquid.
c. Ideal gas law and real gas law

Answer

a-Intensive properties are properties which do not depend on the mass of matter but depends on the **type** of matter e,g, Pressure, temperature, velocity, density, viscosity and boiling and melting point.

Extensive properties are properties, which depend on the mass of matter e,g, Volume, surface area, weight, number of moles, all forms of energy e.g. kinetic energy, potential energy.

b- The temperature **increase** solubility of solid in liquid and **decrease** solubility gas in liquid.

c-Ideal gas law is PV = nRT, while real gas law is $(P + an^2/V^2)(V-nb) = nRT$

Question 2 (5 marks)

Consider the reaction

$$2SO_{2(g)} + O_{2(g)} \rightarrow 2SO_{3(g)}$$

carried out at 25°C and 1 atm. **Calculate** ΔH^o, ΔS^o, ΔE and ΔG^o using the following data:

Substance	ΔH_F^o(kj/mol)	S^o (j/K. mol)
SO_2 (g)	- 297	248
SO_3 (g)	- 396	257
O_2 (g)	0	205

Determine if low or high temperatures suitable for reaction to be spontaneous.

Answer

$$\Delta H^\circ = \Sigma n_p \Delta H^\circ_{f(products)} - \Sigma n_r \Delta H^\circ_{f(reactants)}$$

ΔH^o = [2(-396)]-[2(-297) + 0] = -198 kJ

$$\Delta S^\circ = \Sigma n_p S^\circ_{products} - \Sigma n_r S^\circ_{reactants}$$

ΔS^o = [2(257)]-[2(248) + 1(205)] = -187 J/K

Since $\Delta E = \Delta H - \Delta nRT$ **So**

ΔE = -198 (kj) –(2-3)(0.008314)(25+273) = -195.5 Kj

The value of ΔG^{o} can now be calculated from the equation

$$\Delta G^{o} = \Delta H^{o} - T\Delta S^{o} = -198 \text{ kJ} - (25+273)(-0.187 \text{ kJ/K}) = -142 \text{ kJ}$$

- Since the sign of ΔH and ΔS are –ve **so the reaction is spontaneous at low temperature**

Question 3 (3 marks, one mark for each point)

A vessel of volume 22.4 L contains 2.0 mol H_2 and 1.0 mol N_2 at 273.15 K. Calculate (a) the mole fractions of each component, (b) their partial pressures, and (c) their total pressure.

Answer

Mole fraction of $H_2 = \frac{number\ of\ moles\ of\ H2}{total\ number\ of\ moles} = \frac{2}{3}$

Mole fraction of $N_2 = \frac{number\ of\ moles\ of\ N2}{total\ number\ of\ moles} = \frac{1}{3}$

For H_2: $P_{H2}V = n_{H2}RT$ **So**

P_{H2} x 22.4 = 2 x 0.082 x 273.15 = 2 atm

For N_2: $P_{H2}V = n_{N2}RT$ So

P_{N2} x 22.4 = 1 x 0.082 x 273.15 = 1 atm

$P_{total} = P_{H2} + P_{N2} = 2 + 1 = 3$ atm

Question 4 (3 marks)

Calculate the vapor-pressure lowering of water when 5.67 g of glucose (molecular mass = 180) is dissolved in 25.2 g of water at 25°C. The vapor pressure of water at 25 °C is 23.8 mmHg. What is the vapor pressure of the solution?

Answer

- Since number of moles of glucose = m/M = 5.67/180 = 0.032 mole
- Number of moles of water = m/M = 25.2/18 = 1.4 mole
- Total number of moles = 0.032 + 1.4 = 1.432 mole

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- Mole fraction of water = number of moles of water/total number of moles = 1.4/1.432 = 0.977
- Since $P_A = P^o_A \cdot X_A$
- Vapor pressure of solution = 23.8 x 0.977 = 23.25 mm Hg
- Vapor-pressure lowering (ΔP) = Vapor pressure of pure solvent - vapor pressure of solution = 23.8 -23.25 = 0.65 mm Hg

Question 5 (3 marks)

A sample of 0.001 g protein was dissolved in enough water to make 1 mL solution of osmotic pressure 1.12 torr at 25 °C. ***Determine*** the molecular mass of protein sample.

Answer

Since π (osmotic pressure) = M (molarity) X R X T

Since osmotic pressure = 1.12/760 = 0.00147 atm, R = 0.082 atm.L/mol. K and T = (25+273=298 °K)

$$\pi = \frac{mass\ of\ solute}{Mol.mass\ of\ solute\ X\ volume\ of\ soln\ (L)} \text{ X R X T}$$

$$\text{So } 0.00147 = \frac{0.001}{Mol.mass\ of\ solute\ X\ 0.001} \text{ X } 0.082 \text{ X } 298$$

Mol. Mass = 16623.13 g/mol

Best Wishes

Associate. Prof. Dr. Khaled Samir Mohamed