

Answer the following questions

Total Marks 80

أجب عن الأسئلة الآتية:

Question No. (1): (15 Marks)

- (a) Define the concept of partial pressure and derive the relationship between partial pressure, total pressure and mole fraction of a component gas in a gas mixture? (4)
- (b) List two conditions under which gas can deviate from ideal behaviour and show how you can obtain van der Waals equation of state by the modification of the ideal gas equation of state? (5)
- (c) A city gas has the following composition by volume: CO₂=2%, C₂H₄= 8%, O₂=1%, C₂H₆=10%, H₂=40%, CO=34%, and N₂=5% Compute the molecular weight of city gas and its density at 27 °C and 730 torr? (N=14 C=12, H=1 and O=16) (6)

Question No. (2) (12 Marks)

- (a) State the three laws of thermodynamic? (3)
- (b) Derive the relationship between C_p and C_v for Real and, ideal gases? (3)
- (c) Calculate the standard enthalpy change ΔH_r for the following reaction at 25°C. (6)
- $$2\text{NaHCO}_3(\text{s}) \longrightarrow \text{Na}_2\text{CO}_3(\text{s}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{g})$$
- and discuss the spontaneity of the reaction, if you are given the following thermodynamic data at 25°C.

Compound	State	ΔG° Kcal/ mol	S° cal/ mol
NaHCO ₃	s	-202.9	36.9
Na ₂ CO ₃	s	-249.6	32.4
CO ₂	g	-94.26	51.1
H ₂ O	g	-54.63	45.1

Question No. (3): (15 Marks)

- (a) Define the heating value of fuel and how it is expressed? (5)
- (b) Compare between the theoretical flame temperature of a gas containing 20% CO and 80% N₂, (by volume), when burned with 100% excess air, if both air and gas initially being at 25°C and 1000°C? (10)
- (consider Cp(O₂) = 8.27 + 0.000258T, Cp(N₂) = 6.5 + 0.001T, Cp(CO₂) = 10.34 + 0.00274T, Cp(CO) = 6.6 + 0.0012T and for CO (ΔH_c)_{25°C} = -67.6 Kcal/ mole)

Question No. (4): (15 Marks)

- (a) Explain Raoult's law for ideal solutions? (3)
- (b) Calculate the total vapor pressure at 30°C, freezing point and boiling point of a solution containing 68.4 g of sugar, (C₁₂H₂₂O₁₁), in 900 g of H₂O? (consider at 30°C, P^o_{H₂O} = 23.5 torr, ΔH_{fus.} = 1436 cal/mol and ΔH_{vap.} = 9718 cal/mol for water) (6)
- (c) How many grams of O₂ are dissolved in a round lake that is 1.6 km in diameter and an average of 6 m deep. Assume that O₂ obeys Henry's law when dissolved in water at 25°C and the atmospheric pressure is 760 torr? You are given that O=16, H=1, the air contain 21% O₂ by volume, density of water = 1 gm/cm³ and Henri's constant for O₂ = 33.3x10⁶ mmHg (6)

Question No. (5): (15 Marks)

- (a) Explain the main features of the phase diagram of water? State the phase rule and apply this rule on the phase diagram of water? (7)
- (b) Calculate the melting point and the boiling point of water at 10 atm. pressure, where the density of liquid water at 0°C is given as 0.99 gm/cm³ and that for ice at 0°C is 0.92 gm/cm³? (8)
- Consider that both (ΔH_{fus.} = 1436 cal/mol) and (ΔH_{vap.} = 9718 cal/mol) for water

Question No. (6): (12 Marks)

- (a) Give different examples of anodic and cathodic reactions? (3)
- (b) Based on the relation between electrode potentials and free energy change, derive the Nernst equation? (3)
- (c) At equimolar concentrations of Fe²⁺ and Fe³⁺, (6)
- (i) What must [Ag⁺] be so that the voltage of the galvanic cell made from the (Ag⁺/Ag) and (Fe³⁺/Fe²⁺) equals zero? Fe²⁺ + Ag⁺ ⇌ Fe³⁺ + Ag
- (ii) Determine the equilibrium constant at 25°C for the reaction.

You are given that: Fe³⁺ + e⁻ ⇌ Fe²⁺ E^o_{cell} = 0.77 volt & Ag⁺ + e⁻ ⇌ Ag E^o_{cell} = 0.8 volt

Question No. (7): (10 Marks)

- (a) Mention the main constituents of Portland cement and express them in clinker chemistry notation? (3)
- (b) In a simplified flow sheet diagram, explain the main steps of Portland cement manufacture? and what are the factors that have to be considered in proportionating raw materials for cement clinker? (3)
- (c) Explain the main features of the kiln used for burning the raw mix to produce Portland cement and explain the main reactions occurring inside it? (4)