

Answer the following Questions Assume any missing data Total Marks 80

Question No. (1):

(15 Marks)

- 5 (a) Show how you can obtain the values of the universal gas constant R in three different units of energy?
4 (b) Explain the concept of the pure component volume of a component gas in a mixture of gases? State the law relates the total volume with the partial volume of each component?
6 (c) A mixture of CaCO_3 and NaHCO_3 is heated, and the compounds decompose according to the following equations: $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$ and $2\text{NaHCO}_3(\text{s}) \rightarrow \text{Na}_2\text{CO}_3(\text{s}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{g})$
If 980 cc. of CO_2 measured at temperature of 27°C and 735 torr. pressure, and 0.495 gm of H_2O were obtained from the decomposition of the sample, what was the original mole fraction of NaHCO_3 in the original sample?

Question No. (2):

(15 Marks)

- 4 (a) Explain the three laws of thermodynamics?
3 (b) Which of the following properties are considered as intensive and which are considered as extensive properties for a system: (i) Pressures. (ii) Temperature. (iii) Velocity. (iv) Volume. (v) Surface area. (vi) Internal energy. (vii) Enthalpy of combustion?
8 (c) Calculate the standard enthalpy change ΔH°_r at 25°C for $2\text{NaHCO}_3(\text{s}) \rightarrow \text{Na}_2\text{CO}_3(\text{g}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{g})$ and discuss the spontaneity of the reaction, if you are given the following thermodynamic data at 25°C ?

Compound	State	ΔG°_f Kcal/ mol	S° cal/ mol. K
NaHCO_3	s	-202.9	36.9
Na_2CO_3	s	-249.6	32.4
CO_2	g	-94.26	51.06
H_2O	g	-54.63	45.10

Question No. (3):

(15 Marks)

- 5 (A) Define the heating value of fuel and how it is expressed?
10 (b) For the production of sulfuric acid by the contact process, iron pyrites, (FeS_2), is burned with air in 100% excess of that required to oxidize all iron to Fe_2O_3 and all sulfur to SO_2 . It may be assumed that the combustion of the pyrites is complete to form these products and that no SO_3 is formed in the burner. The gases from the burner are cleaned and then passed into a catalytic converter in which 70% of SO_2 is oxidized to SO_3 by combination with the oxygen present in the gases. The gases enter the converter at a temperature of 400°C . Assuming the converter is an adiabatic system. Calculate the temperature of the gases leaving the converter? If you are given C_p for gases (cal/mole.deg.) $\text{O}_2 = 8.27 + 0.000258 T$, $\text{SO}_2 = 7.70 + 0.0053 T$
 $\text{SO}_3 = 6.66 + 0.0183 T$, $\text{N}_2 = 6.50 + 0.001T$ and (ΔH°_f) for $\text{SO}_3 = -94.455$ and $\text{SO}_2 = -70.961$ k.cal/mol

Question No. (4):

(15 Marks)

- 5 (a) Explain the phenomena of osmosis? And what is meant by isotonic, hypotonic and hypertonic solutions?
6 (b) How many grams of O_2 are dissolved in a round lake that is 1.6 km in diameter and an average of 6 m deep. Assume that O_2 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% O_2 by volume, density of water = 1 gm/cm^3 and Henri's constant for $\text{O}_2 = 33.3 \times 10^6 \text{ mmHg}$.
4 (c) When 0.555 gm of a solute, (molecular weight = 110 gm/mole), is dissolved in 100 gm. of solvent, (molecular weight = 94.10 gm/mole and normal freezing point = 318.1 K), a freezing point lowering for the solvent of 0.382°C occurs. Calculate:
(i) K_f , the molal freezing point lowering constant. (ii) The enthalpy of fusion for the solvent.

Question No. (5):

(20 Marks)

- 2 (a) Give different four examples of cathodic reactions?
3 (b) Based on the relation between electrode potentials and free energy change, derive the Nernst equation?
4 (c) Calculate the standard electrode potential, E° , for the half-cell, ($\text{Fe}^{+++} + 3e^- \rightarrow \text{Fe}$) if you are given:
 $\text{Fe}^{++} + 2e^- \rightarrow \text{Fe}$ $E^\circ_1 = -0.440 \text{ volt}$ $\text{Fe}^{+++} + e^- \rightarrow \text{Fe}^{++}$ $E^\circ_2 = 0.771 \text{ volt}$
4 (d) In a simplified flow sheet diagram, explain the main steps of Portland cement manufacture?
5 (e) 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?
2 (f) Explain (graphically) the development of compressive strength on the hydration of the main constituents of Portland cement?