

Course: CHM202

Energetics and dynamics of chemical reactions

Assignment – V

Q.1 Methane gas is heated from 25 °C until the volume has doubled. The pressure is constant at 1 bar. The variation in molar heat capacity with temperature has been measured and the results of those experiments can be summarized by the equation-

$$C_p = a + bT$$

where $a = 22.34 \text{ JK}^{-1}\text{mol}^{-1}$ and $b = 48.1 \times 10^{-3} \text{ JK}^{-2}\text{mol}^{-1}$. Calculate ΔH and ΔU per mol. Assume the system follows the ideal gas behaviour.

Q.2 Compute change in Gibbs free energy for the process $\text{H}_2\text{O} (l, -10^\circ\text{C}) = \text{H}_2\text{O} (s, -10^\circ\text{C})$. Specific heat of water and ice over the temperature range is 18 and 9 Cal.mol^{-1} , respectively and $\Delta H_{fus_{273}} = 1440 \text{ Cal.mol}^{-1}$. Predict whether the change is spontaneous or not.

Q.3 Calculate entropy change per litre of the solution when pure N_2 , H_2 , NH_3 gases are mixed to form a solution having the final composition 15% N_2 , 55% H_2 and 30% NH_3 (all at STP).

Q.4 Establish the condition for spontaneous vaporization of water, given $\Delta H = 9590 \text{ Cal.mol}^{-1}$ and $\Delta S = 26 \text{ e.u.}$ for the process.

Q.5 Describe a reversible process by which one mole of water at 100 °C can be converted to vapour at 0.5 atm and 100 °C. Calculate ΔH and ΔG for the process. How far these quantities would be affected if the operation were performed irreversibly? Assume water vapour behave ideally and latent heat of vaporization of water = 540 Cal.gm^{-1} .

Q.6 Calculate the change in Gibbs potential when 36 gm water initially at 100 °C and 10 atm pressure are converted to vapour at 100 °C and 0.01 atm pressure. Assume water vapor behave ideally.

Q.7 One mole of benzene at the normal boiling point of 352.2K vaporises into a gaseous state at a pressure of 0.1 atm. Calculate ΔS and ΔG . Given the enthalpy of vaporization is 7364 Cal.mol^{-1} .

Q.8 Determine the change in entropy when 1 kg ice at 0 °C and 1 atm is heated to 373 °C and 2 atm pressure. Given $\Delta H_{fus_{273}} = 1440 \text{ Cal.mol}^{-1}$; $\Delta H_{vap_{373}} = 9720 \text{ Cal.mol}^{-1}$; $C_{p_L} = 18 \text{ Cal.K}^{-1}\text{mol}^{-1}$ and $C_{p_V} = 8 \text{ Cal.K}^{-1}\text{mol}^{-1}$.

Q.9 One mole of O_2 ($C_V = \frac{5}{2}R$) initially at 546K and 10 atm expands adiabatically against a constant pressure of 1 atm until the volume becomes doubled. Calculate ΔU , ΔH and ΔS for the process.

Q.10 One mole of an ideal gas ($C_V = \frac{5}{2}R$) is taken reversibly from 400K, 5 atm to 600K, 2 atm. Calculate ΔU , ΔH and ΔG for the process. Given: $\bar{S}_{298}^0 = 4J^{-1}K^{-1}\text{mol}$.