Assignment 4

Indian Institute of Science Education and Research

CHM202: Energetics and dynamics of chemical reactions

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Ques. 1 Calculate the change in entropy when 1 kg ice at 0^0C and 1 atm is heated to 373 K and 2 atm pressure. Given ΔH_{fus} (273 K) = 1440 cal. mol^{-1}, ΔH_{vap} (373 K) = 9720 cal. mol^{-1}, C_P (liquid) = 18 cal. K^{-1} mol^{-1}, C_P (vapour) = 8 cal. K^{-1} mol^{-1}.

Ques.2 Calculate the ΔG for the process $H_2O\ (l, -10^0C) \longrightarrow H_2O\ (s, -10^0C)$.

Given $\overline{C}_P$ (liquid) = 18 cal. K^{-1} mol^{-1}, $\overline{C}_P$ (solid) = 9 cal. K^{-1} mol^{-1}, ΔH_{fus} (273 K) = 1440 cal. mol^{-1}. Predict whether the change is spontaneous or not.

Ques.3 A 2 kilowatt Carnot engine working between 400 K and 300 K runs a refrigerator which works between 0^0C and 27.3^0C. If the refrigerator produces 3 kg of ice per minute from water at 0^0C. Calculate the rate of heat leakage to the refrigerator. Also calculate the amount of heat needed for the engine per minute. ΔH_{fus} = 334.72 J g^{-1}.

Ques.4 Two empirical equations of state of a real gas are as follows:

$$\text{Van der waals: } P = (RT/V_m - b) - (a/V_m^2)$$

$$\text{Dieterici: } P = (RTe^{-a/RTV_m}) / (V_m - b)$$

Evaluate $(\ dS/\ dV\ )_T$ for each gas. For an isothermal expansion, for which kind of gas (also consider a perfect gas) will ΔS be greatest? Explain your conclusion.

Ques.5 For a first-order phase transition, to which the clapeyron equation does apply, prove the relation

$$C_s = C_p - (\propto V \Delta_{trs} H / \Delta_{trs} V)$$

Where $C_s = (\delta q/\delta T)_S$ is the heat capacity along the coexistence curve of two phases.

Ques.6 The normal boiling point of hexane is 69^0C. Estimate (i) its enthalpy of vapourization and (ii) its vapour pressure at 25^0C and 60^0C.