

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°C and 1 atm is heated to 373 K and 2 atm pressure. Given $\Delta H_{\text{fus}}(273 \text{ K}) = 1440 \text{ cal. mol}^{-1}$, $\Delta H_{\text{vap}}(373 \text{ K}) = 9720 \text{ cal. mol}^{-1}$, $C_P(\text{liquid}) = 18 \text{ cal. K}^{-1} \text{ mol}^{-1}$, $C_P(\text{vapour}) = 8 \text{ cal. K}^{-1} \text{ mol}^{-1}$.

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

Given $\bar{C}_P(\text{liquid}) = 18 \text{ cal. K}^{-1} \text{ mol}^{-1}$, $\bar{C}_P(\text{solid}) = 9 \text{ cal. K}^{-1} \text{ mol}^{-1}$, $\Delta H_{\text{fus}}(273 \text{ K}) = 1440 \text{ cal. mol}^{-1}$. 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°C and 27.3°C. If the refrigerator produces 3 kg of ice per minute from water at 0°C. Calculate the rate of heat leakage to the refrigerator. Also calculate the amount of heat needed for the engine per minute. $\Delta H_{\text{fus}} = 334.72 \text{ J g}^{-1}$.

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

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

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°C. Estimate (i) its enthalpy of vapourization and (ii) its vapour pressure at 25°C and 60°C.