Assignment 3

Indian Institute of Science Education and Research

CHM202: Energetics and dynamics of chemical reactions

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Ques. 1 From the following data, determine $\Delta_f H^0$ for diborane, $B_2H_6(g)$, at 298 K:

(1) $B_2H_6(g) + 3\ O_2(g) \rightarrow B_2O_3(s) + 3\ H_2O(g)$ $\quad \Delta_r H^0 = -1941\ \text{kJ mol}^{-1}$
(2) $2\ B(s) + 3/2\ O_2(g) \rightarrow B_2O_3(s)$ $\quad \Delta_r H^0 = -2368\ \text{kJ mol}^{-1}$
(3) $H_2(g) + 1/2\ O_2(g) \rightarrow H_2O(g)$ $\quad \Delta_r H^0 = -241.8\ \text{kJ mol}^{-1}$

Ques.2 The volume of a certain liquid varies with temperature as

$$V = V'\{0.77 + 3.7 \times 10^{-4}(T/\text{K}) + 1.52 \times 10^{-6}(T/\text{K})^2\}$$

where V' is its volume at 298 K. Calculate its expansion coefficient, α, at 310 K.

Ques.3 If U is a function of Temperature and volume, then prove $\left(\frac{\partial U}{\partial T}\right)_P = C_V + \Pi V\alpha$.

Where $\Pi = \left(\frac{\partial U}{\partial V}\right)_T$ and α is Thermal expansion coefficient.

Ques.4 Calculate the isothermal compressibility (β) and the expansion coefficient (α) of a van der Waals gas. Show, using Euler's chain relation, that $\beta TR = \alpha(V\text{m} - b)$.

Ques.5 (a) Express $\left(\frac{\partial C_V}{\partial V}\right)_T$ as a second derivative of U and find its relation to $\left(\frac{\partial U}{\partial V}\right)_T$ and $\left(\frac{\partial C_P}{\partial P}\right)_T$ as a second derivative of H and find its relation to $\left(\frac{\partial H}{\partial P}\right)_T$. (b) From these relations show that $\left(\frac{\partial C_V}{\partial V}\right)_T = 0$ and $\left(\frac{\partial C_P}{\partial P}\right)_T = 0$ for a perfect gas.