Marks 3

- Consider the following reaction:

$$2N_2O(g) + 3O_2(g) \rightarrow 4NO_2(g)$$

Calculate $\Delta G°$ for this reaction given the following data.

$4NO(g) \rightarrow 2N_2O(g) + O_2(g)$ $\quad\quad \Delta G° = -139.56$ kJ mol^{-1}

$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$ $\quad\quad \Delta G° = -69.70$ kJ mol^{-1}

Using $\Delta_r G° = \sum \Delta_f G°$(products) – $\sum \Delta_f G°$(reactants), the free energy changes in the 3 reactions are, respectively:

$\Delta_r G°(1) = 4\Delta_f G°(NO_2(g)) - 2\Delta_f G°(N_2O(g))$

$\Delta_r G°(2) = 2\Delta_f G°(N_2O(g)) - 4\Delta_f G°(NO(g)) = -139.56$ kJ mol^{-1}

$\Delta_r G°(3) = 2\Delta_f G°(NO_2(g)) - 2\Delta_f G°(NO(g)) = -69.70$ kJ mol^{-1}

Mathematically, the combination $2\Delta_r G°(3) - \Delta_r G°(2)$ leads to $\Delta_r G°(1)$:

$$2\Delta_r G°(3) = 4\Delta_f G°(NO_2(g)) - 4\Delta_f G°(NO(g))$$

$$\Delta_r G°(2) = 2\Delta_f G°(N_2O(g)) - 4\Delta_f G°(NO(g))$$

$$2\Delta_r G°(3) - \Delta_r G°(2) = 4\Delta_f G°(NO_2(g)) - 2\Delta_f G°(N_2O(g)) = \Delta_f G°(1)$$

$\Delta_f G°(1) = 2\Delta_r G°(3) - \Delta_r G°(2) = [(2 \times -69.70) - (-139.56)]$ kJ mol^{-1}

$= 0.16$ kJ mol^{-1}

Answer: **0.16 kJ mol^{-1}**

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