LESSON 5

35. The reaction between ideal gases

\[
\text{CH}_4(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{CO}(\text{g}) + 3 \text{ H}_2(\text{g})
\]

At 600 K, has \( \Delta H^\circ = 217.9 \text{ kJ}\cdot\text{mol}^{-1} \) and \( K_p^\circ = 4.9\cdot10^{-7} \)

a) Estimate if at 1010 K the equilibrium constant will be higher or lower. Justify your answer using the appropriate equations

b) Will the result be different if the gases have real behaviour?

36. Consider the following chemical equilibrium between ideal gases:

\[
\text{A} \rightleftharpoons 2\text{B}
\]

at constant temperature and pressure. Express the mole fractions in the equilibrium, \( x_A \) and \( x_B \) versus \( K_p^\circ \) and \( P \).

37. Indicate whether the following statements for reactions between ideal gases are true or false:

a) \( K_p^\circ \) is always dimensionless

b) \( K_p^\circ \) of the reverse reaction is the same as the \( K_p^\circ \) of the forward reaction, but with the opposite sign

c) multiplying by two the stoichiometric coefficients, it means double \( K_p^\circ \)

d) \( K_p^\circ \) of a particular reaction depends on the temperature, but it is independent of pressure and of the initial composition of the reaction mixture.

Justify the answers
38. Determine the effects of the following changes on this endothermic reaction at 25°C:

\[ \text{CH}_4(g) + \text{HCl}(g) \rightleftharpoons \text{CH}_3\text{Cl}(g) + \text{H}_2(g) \]

a) an increase in \( X(\text{HCl}) \)
b) a decrease in \( X(\text{H}_2) \)
c) a pressure rise
d) an increase in temperature.

39. Indicate, justifying the answer, if the following statements are true or false for the forming reaction of solid L-alanine, \( \text{C}_3\text{H}_7\text{O}_2\text{N} \), with \( \Delta G^\circ_{298} \) equal to -88.48 kcal·mol\(^{-1}\):

a) The reaction is spontaneous
b) The equilibrium constant \( K^\circ_p \) is less than 1
c) If \( \Delta S^\circ_{298} \) of L-alanine \( \text{C}_3\text{H}_7\text{O}_2\text{N}(s) \) is negative, the reaction is spontaneous

40. Indicate which of the following quantities can never be negative:

a) \( \Delta G^\circ_T \)
b) \( \Delta G^P_T \)
c) \( K^\circ_p \)