Quiz 18.2 – Gibbs Energy and Temperature

Name: Key

Consult Appendix A.2 in your textbook to answer questions on this quiz

Question 1

ΔH_f° −110.5 −241.8 Ø −393.5 kJ/mol

Consider the reaction: $CO(g) + H_2O(g) \rightleftharpoons H_2(g) + CO_2(g)$

S° 197.7 188.8 130.7 213.8 J/mol·K

- Find ΔH° and ΔS° for this reaction

$\Delta H^\circ_{rxn} = 0 - 393.5\ kJ/mol + 110.5\ kJ/mol + 241.8\ kJ/mol = -41.2\ kJ/mol$

$\Delta S^\circ_{rxn} = 130.7\ J/mol\,K + 213.8\ J/mol\,K - 197.7\ J/mol\,K - 188.8\ J/mol\,K = -42.0\ J/mol\,K$

- Find ΔG° at $T = 315\ K$

$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ = -41.2\ kJ/mol - 315K \cdot -0.042\ kJ/mol\,K = -28.0\ kJ/mol$

- Under what temperature conditions is this reaction spontaneous at standard concentrations? (Give a specific threshold temperature, if applicable)

$\emptyset = \Delta H^\circ - T\Delta S^\circ \rightarrow T = \frac{\Delta H^\circ}{\Delta S^\circ} = \frac{-41.2\ kJ/mol}{-0.042\ kJ/mol\,K}$ = Less than 981 K

Question 2

ΔH_f° −45.9 Ø Ø kJ/mol

Consider the Reaction: $2\,NH_3(g) \rightleftharpoons N_2(g) + 3\,H_2(g)$

S° 192.8 191.6 130.7 J/mol·K

- Find ΔH° and ΔS° for this reaction

$\Delta H^\circ_{rxn} = \emptyset + \emptyset - 2\cdot(-45.9\ kJ/mol) = 91.8\ kJ/mol$

$\Delta S^\circ_{rxn} = 191.6\ J/mol\,K + 3\cdot 130.7\ J/mol\,K - 2\cdot 192.8\ J/mol\,K = 198\ J/mol\,K$

- Find ΔG° at $T = 550\ K$

$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ = 91.8\ kJ/mol - 550K \cdot 0.198\ kJ/mol\,K = -17.1\ kJ/mol$

- Under what temperature conditions is this reaction spontaneous at standard concentrations? (Give a specific threshold temperature, if applicable)

$\emptyset = \Delta H^\circ - T\Delta S^\circ \rightarrow T = \frac{\Delta H^\circ}{\Delta S^\circ} = \frac{91.8\ kJ/mol}{0.198\ kJ/mol\,K}$ = Greater than 464 K