Answer on Question #60855 - Chemistry - Other

Task:

What is the minimum temperature for the following reaction to occur?

CaO + SiO2 --> CaSiO3

Solution:

$$CaO + SiO_2 \rightarrow CaSiO_3.$$

The standard-state enthalpy of reaction is equal to the sum of the enthalpies of formation of the products minus the sum of the enthalpies of formation of the reactants:

$$\Delta H^o(reaction) = \sum \Delta H_f^o(products) - \sum \Delta H_f^o(reac\tan ts).$$

$$\Delta H^o(reaction) = \Delta H_f^o(CaSiO_3) + \Delta H_f^o(SiO_2) - \Delta H_f^o(CaO).$$

$$\Delta H^o(reaction) = -1584{,}1 - (-859.3) - (-635.1) = -89.7(kJ \times mol^{-1}).$$

The standard entropy of reaction is equal to the sum of the entropies of the products minus the sum of the entropies of the reactants:

$$\Delta S(reaction) == \sum \Delta S(products) - \sum \Delta S(reac\tan ts).$$

$$\Delta S(reaction) = 82 - 42.1 - 39.7 = 0.2(J \times mol^{-1}).$$

For a favorable reaction (ΔG < 0), |ΔH| must be smaller than |TΔS|, or ΔG must go through zero.

So the temperature where ΔG is zero is the temperature where the spontaneity changes.

ΔG = ΔH - TΔS

0 = ΔH - TΔS

ΔH/ΔS = T

T = 89700 J/mol/(0.2 J/mol K) = -448500 K

So, T must be greater than -448500 K