

Question 1

Given the following reaction: $\text{PbO(s)} + \text{CO(g)} \rightleftharpoons \text{Pb(s)} + \text{CO}_2\text{(g)}$.

The standard Gibbs energy for this reaction ($\Delta_r G^\ominus_{298\text{K}}$) is: $-68.3 \text{ kJ mol}^{-1}$, the standard enthalpy of reaction $\Delta_r H^\ominus_{298\text{K}}$ is $-63.99 \text{ kJ mol}^{-1}$ and the standard entropy of reaction $\Delta_r S^\ominus_{298\text{K}}$ is $14.4 \text{ J mol}^{-1} \text{ K}^{-1}$.

Calculate the equilibrium constant at the temperatures:

- a) 298 K
- b) 400 K

Use the data given above. Assume $\Delta_r H$ and $\Delta_r S$ are temperature-independent.

Question 2

HI decomposes to I_2 and H_2 in a reactor at 1000 K and 1.00 bar overall pressure:



22.8% of the initial HI has decomposed after equilibrium has been established.

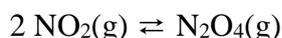
You may assume that the gases behave as perfect gases.

In equilibrium, what is the value of:

- a) $\Delta_r G$
- b) K
- c) $\Delta_r G^\ominus$

Question 3

The standard Gibbs energy of the reaction below is $-4.73 \text{ kJ mol}^{-1}$ at 298 K.



- a) The partial pressure of NO_2 is equal to 6.0 bar and that of N_2O_4 is 2.0 bar. Calculate the Gibbs energy of the reaction at 298 K. You may assume that the gases behave as perfect gases.
- b) In what direction does the reaction proceed spontaneously at 298 K?

Additional material:**Question 4**

For the dehydration of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ the $\Delta_r H^\ominus_{298\text{K}} = 299 \text{ kJ mol}^{-1}$ and the $\Delta_r S^\ominus_{298\text{K}} = 753 \text{ J mol}^{-1} \text{ K}^{-1}$.

Estimate the temperature at which $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ undergoes dehydration.

To answer this question some sensible assumptions have to be made. Give these assumptions and the calculation.