University Center Abdelhafid Bousouf - Mila

Institute of Science and Technology

Subject: Thermodynamics Academic Year: 2024/2025

Series Nº 5

Exercise 1:

First Year ST

- 1. Write the reaction for the formation of hydrogen peroxide (H₂O₂) from H₂ (gas) and O₂ (gas).
- 2. Calculate the change in reaction enthalpy (ΔH°_{r}) , the change in reaction entropy (ΔS°_{r}) , and the change in Gibbs free energy (ΔG°_{r}) for hydrogen peroxide in the liquid state.
- 3. Is hydrogen peroxide stable compared to its constituent elements?
- 4. The H₂O₂ (liq) molecule can decompose into water and O₂ (gas). Write the equilibrium equation (knowing that 1 mole of O₂ is formed).
- 5. Calculate the change in Gibbs free energy for this reaction.
- 6. Calculate the thermodynamic equilibrium constant for this reaction.
- 7. Is hydrogen peroxide stable compared to water and oxygen?

Given thermodynamic data at 298 K:

Compound	ΔH°f (kJ/mol)	S° (J/K·mol)
$H_2O_2(l)$	-187.6	143
H ₂ O (l)	-285.6	70
$O_{2}(g)$	0	205
$H_{2}(g)$	0	130

Exercise 2:

Consider the following gaseous equilibrium:

$$N_2O_{4(g)} \leftrightarrow 2NO_{2(g)}$$

At 25°C, the equilibrium constant Kc takes the value 172.

If we add **2 moles of N_2O_4** and **5 moles of NO_2** to a **10-liter vessel** at this temperature, calculate the number of moles of each component at equilibrium.

Exercise 3:

We add **0.2 moles of PCl₅** and **0.1 moles of Cl₂** to a container at **523 K**, where the total pressure is P = 1 atm. Calculate the **degree of dissociation** (α) of PCl₅ under these conditions, given that the equilibrium constant at this temperature is KP=0.4.

The equilibrium reaction is:

$$PCl_{5(g)} \leftrightarrow PCl_{3(g)} + Cl_{2(g)}$$