

Exercise Series N° 4

Exercise 1:

One mole of a solid substance, initially at 25°C, is introduced into a preheated oven at 900°C. Knowing that between 25°C and 900°C, this substance remains solid and its molar heat capacity at constant pressure is equal to 30 J.K⁻¹.mol⁻¹

- 1) Calculate the entropy change of the solid.
- 2) Calculate the variation in entropy exchanged between the oven and the solid.
- 3) Deduce the variation in entropy created during the heating process.

Exercise 2 :

We heat, at atmospheric pressure, one mole of iodine (I₂, s) from 25°C to 150°C. Knowing that under these conditions, solid iodine melts at 114°C. Determine, under these conditions, the entropy change created during this transformation.

We give:

$\Delta H^\circ_{\text{fusion}}(\text{I}_2, \text{s}) = 15,6 \text{ KJ/mol}$; $c_p(\text{I}_2, \text{s}) = 54,6 \text{ J/K.mol}$; $c_p(\text{I}_2, \text{l}) = 81,5 \text{ J/K.mol}$.

Exercise 3 :

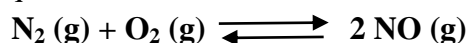
Let's consider the following equilibrium: $\text{CH}_3\text{CHO}(\text{g}) \rightleftharpoons \text{CH}_2=\text{CHOH}(\text{g})$

We ask for:

- 1) The expression of the law of mass action relating to partial pressures.
- 2) The value of the equilibrium constant K_P at 25°C knowing that the entropy change ΔS°_R of the reaction is practically zero and that the enthalpy changes ΔH°_f have the values -166.35 KJ/mol for CH₃CHO and -130.70 KJ/mol for CH₂=CHOH.
- 3) Specify the most stable chemical form.
- 4) What happens to K_P if the temperature is 100°C (assuming ΔH°_R is constant between 25°C and 100°C).
- 5) Study the influence of temperature and pressure variations on the previous equilibrium.

Exercise 4:

Consider the following gas phase equilibrium:



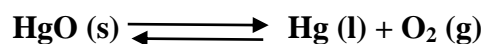
- 1) Complete the following table of thermodynamic data for temperature $T_1 = 298 \text{ K}$.

Compounds	N ₂ (g)	O ₂ (g)	NO (g)
C _p (J/K.mol)	29,12	29,36	29,86
S° (J/K.mol)	191,49	205,03	210,62
ΔH° _f (KJ/mol)	?	?	90,37
ΔG° _f (KJ/mol)	?	?	?

- 2) Calculate the enthalpy of the reaction at temperature $T_2 = 318$ K. We will assume that the molar heat capacities of the gases are constant in the temperature range considered.
- 3) Calculate the value of the equilibrium constant at temperature T_2 .
- 4) In which direction does the equilibrium shift as the temperature increases? When equilibrium is reached, what would be the influence of the introduction of an inert gas?

Exercise 5 :

Given the following equilibrium achieved at 298 K:



- 1) Balance the reaction and calculate the change in free enthalpy of the reaction at 298 K.
 - 2) Calculate the pressure of oxygen in equilibrium with HgO (solid) at 298 K.
 - 3) In which direction will the equilibrium shift if:
 - a) The temperature is increased?
 - b) The total pressure is increased?
 - c) HgO (solid) is added at constant temperature?
- We give: $\Delta H_f^\circ(\text{HgO}) = -90,71$ KJ/mol ; $S^\circ(\text{HgO}) = 72$ J/K.mol ; $S^\circ(\text{Hg}) = 77,4$ J/K.mol ;
 $S^\circ(\text{O}_2) = 205,03$ J/K.mol.