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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 to30 $J.K^{-1}.mol^{-1}$

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 (I_2, 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:

$\Delta H°_{fusion}$ (I_2, s) = 15,6 KJ/mol ; c_p (I_2, s) = 54,6 J/K.mol ; c_p (I_2,l) = 81,5 J/K.mol.

Exercise 3 :

Let's consider the following equilibrium: $\mathbf{CH_3CHO\ (g) \rightleftharpoons CH_2{=}CHOH\ (g)}$

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 $\Delta S°_R$ of the reaction is practically zero and that the enthalpy changes $\Delta H°_f$ have the values -166.35 KJ/ mol for CH_3CHO and -130.70 KJ/mol for CH_2=CHOH.
3) Specify the most stable chemical form.
4) What happens to K_P if the temperature is 100°C (assuming $\Delta H°_R$ 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:

$$\mathbf{N_2\ (g) + O_2\ (g) \rightleftharpoons 2\ NO\ (g)}$$

1) Complete the following table of thermodynamic data for temperature T_1 = 298 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
$\Delta H°_f$ (KJ/mol)	?	?	90,37
$\Delta G°_f$ (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:

$$\mathbf{HgO\ (s) \rightleftharpoons Hg\ (l) + O_2\ (g)}$$

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: $\Delta H°_f$ (HgO) = -90,71 KJ/mol ; S° (HgO) = 72 J/K.mol ; S° (Hg) = 77,4 J/K.mol ; $S°(O_2)$ = 205,03 J/K.mol.