University of Mohamed Khider, Biskra — Academic Year: 2023/2024
Faculty of Exact Sciences, Natural and Life Sciences — Course: Chemistry 2
Department: Materials Science
First Year - Common Trunk

Series N ° :3

Exercise N°1:

The complete combustion of one mole of liquid methanol under standard conditions of pressure and temperature (T = 298 K, P = 1 atm) releases 2,725 kJ, according to the following equation**:**

$$CH_3OH(l) + 3/2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$$

1- Calculate the standard molar enthalpy of formation for liquid methanol.

2- Calculate the enthalpy change for this reaction at 60°C.

3- Determine the change in enthalpy for this reaction at 127°C and under a pressure of 1 atm. It's known that at this pressure, methanol boils at 64.5°C, water at 100°C, and the heat of vaporization is given as: $\Delta H_{Vap(CH3OH)\,l}$ =35,4 kJ/mol; $\Delta H_{Vap(H2O)l}$ = 44 KJ/mol

Data: at 298 K

$\Delta H_{f(CO2)g}$ = -393,5KJ/mol ; $\Delta H_{f\,(H2O)l}$ = -285,2 KJ/mol

The element	$CH_3OH(g)$	$H_2O_{(g)}$	$CH_3OH(l)$	$H_2O_{(l)}$	$CO_{2\,(g)}$	$O_{2\,(g)}$
Cp(J.mol^{-1}.K^{-1})	53,5	38,2	81,6	75,2	36,4	34,70

Exercise N°2:

Let the following chemical reaction occur at a temperature of 298 K:

$$N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$$

1- Calculate the standard molar enthalpy change for this reaction, $\Delta H°_{R,298}$, and deduce the corresponding change in internal energy, $\Delta U°_{R,298}$.

2- Calculate the bond energy of N-H at a temperature of 298 K.

3- Calculate the change in enthalpy for this reaction at 500 K ($\Delta H°_{R,500\,K}$).

$\Delta H°_{f,298}$ (N ≡ N) = -945 KJ/mol ; $\Delta H°_{f,298}$ (H-H) = -335 KJ/mol

The element	$N_{2(g)}$	$H_{2(g)}$	$NH_{3(g)}$
$\Delta H^0_{f,\,298}$(KJ / mole)	0	0	-46,21
C_P (J / mole.^{0}K)	29,13	28,84	35,66

Exercise N°3:

Let the following reaction be:

CH_4 (g) + $4Cl_2$ (g) → CCl_4 (g) + 4 HCl (g) $\Delta H°_R$ **= - 401.08 kJ mol^{-1}**

1- Calculate the standard enthalpy change for this reaction at 650 K.

2- Calculate the standard enthalpy of formation for CCl_4.

3- Calculate the bond energy E(C-Cl).

4- Calculate the standard enthalpy of formation for trichloromethane (chloroform, $CHCl_3$).

Data: at 298 K :

$\Delta H°_{f(HCl)}$ = -92.3 kJ.mol^{-1}; $\Delta H_{vap(CHCl3)}$ =38,5 kJ.mol^{-1}; $\Delta H°_{f(CH4)}$ = -74.6kJ.mol^{-1}; $\Delta H_{Sub(C)}$ =716.6 kJ.mol^{-1}

Element	CH_4 (g)	Cl_2 (g)	HCl(g)	CCl_4 (g)
C_p (J.mol^{-1}.K^{-1})	35.71	33.93	29.12	83.51

Bond	C-H	C-C	C-O	Cl-Cl	H-H
E (kJ.mol^{-1})	414	347	351	242.6	436