University Center Abdelhafid Bousouf - Mila

Institute of Science and Technology **Subject: Thermodynamics**

First Year ST **Academic Year: 2024/2025**

Series Nº 3

Exercise 1:

Consider the following reactions at 289 K:

$5HCN(g) \rightarrow C_5H_5N_5$ **(1)**

$CH_{4(g)} + NH_{3(g)} \rightarrow HCN_{(g)} + 3H_{2(g)}$ **(2)**

- Calculate $\Delta H°_{\mathbf{R(1)}}$ at 289 K, given the following data at 289 K:

$$\Delta H°_{f\left(NH_{3(g)}\right)} = -46\ KJ.mol^{-1}, \Delta H°_{f\left(CH_{4(g)}\right)} = -74{,}8\ KJ.mol^{-1},$$
$$\Delta H°_{f\left(C_5H_5N_{5(S)}\right)} = -46\ KJ.mol^{-1}, \Delta H°_{R\,(\mathbf{2})} = 251.2\ KJ$$

Exercise 2:

Calculate the standard enthalpy of formation of methane gas, $\Delta H°_f$ (CH_4), given the standard enthalpies $\Delta H°$ for the following reactions:

1) $CH_{4(g)} + 2O_{2(g)} \rightarrow 2H_2O_{(l)} + CO_{2(g)}$ $\quad \Delta H_1° = -891\ KJ$

2) $H_{2(g)} + {}^{1}/_{2}\, O_{2(g)} \rightarrow H_2O_{(l)}$ $\quad \Delta H_2° = -285.8\ KJ$

3) $C_{(S)} + O_{2(g)} \rightarrow CO_{2(g)}$ $\quad \Delta H_3° = -393.51\ KJ$

Exercise 3:

Consider the following reaction:

$$2\ Al_{(S)} + {}^{3}/_{2}\, O_{2(g)} \rightarrow Al_2O_{3(S)}$$

1. Calculate the change in enthalpy for this reaction at 500°C and 1 atm pressure, given that the change in enthalpy at 25°C is $\Delta H°_R$ = 1676 kJ.
2. Given that aluminum (Al) melts at 660°C, calculate the change in enthalpy for the same reaction at 750°C and 1 atm pressure.

Given:

$$\Delta H_{fus(Al)} = 10{,}8\ KJ.mol^{-1}.K^{-1}, Cp_{Al(S)} = 24{,}2\ J.mol^{-1}.K^{-1}, Cp_{Al(l)} = 29{,}3\ J.mol^{-1}.K^{-1}$$
$$Cp_{\,Al_2O_{3(S)}} = 81{,}2\ J.mol^{-1}.K^{-1}, Cp_{O_{2(g)}} = 29{,}3\ J.mol^{-1}$$

Exercise 4:

The combustion of ethane occurs according to the following reaction:

$$C_2H_{6(g)} + \frac{7}{2}O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(g)}$$

1. Calculate the heat of combustion at constant volume and at 298 K.
2. Calculate the standard enthalpy of formation of C_2H_6 .
3. Calculate the C-C bond energy in C_2H_6.

Given:

$$\Delta H°_{C(C_2H_6)} = -336{,}65\ Kcal.mol^{-1}, \Delta H°_{f(H_2O(l))} = -68{,}32\ Kcal.mol^{-1}$$
$$\Delta H°_{vap(H_2O)} = 10{,}53\ Kcal.mol^{-1}, \Delta H°_{f(CO_{2(g)})} = -94{,}05\ Kcal.mol^{-1}$$
$$\Delta H°_{sub(\mathrm{C(gr)})} = 171{,}86\ Kcal.mol^{-1}$$
$$E_{C-H} = -98{,}8\ Kcal.mol^{-1}, E_{H-H} = -103{,}2\ Kcal.mol^{-1}$$