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Exercise Series N° 3

Exercise 1:

Calculate the difference between the heat of reaction at constant volume and the heat of reaction at constant pressure in the following two cases:

1) at a temperature of 0°C:

$C_2H_5OH\ (l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(s)$

2) at a temperature of 25°C :

$C_2H_5OH\ (g) + 3O_2\ (g) \rightarrow 2CO_2(g) + 3H_2O(l)$

Exercise 2:

Consider the combustion reaction of ethane at 25°C and 1 atm:

$C_2H_6\ (g) + 7/2\ O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$

1. Calculate the enthalpy change of this reaction $\Delta H_R°$ at 25°C. What does the sign of the value found mean?
2. Calculate the internal energy change $\Delta U_R°$ accompanying this reaction at 25°C.

Data at 25°C: $\Delta H_f°\ (H_2O\ (l)) = -285{,}8$ Kj/mol, $\Delta H_f°\ (CO_2\ (g)) = -394{,}0$ Kj/mol,
$\Delta H_f°\ (C_2H_6\ (g)) = -238{,}2$ Kj/mol.

Exercise 3:

I. The combustion of one mole of liquid methanol, $CH_3OH(l)$, releases 724 kJ at T=298K and P=1atm.

a. Write the combustion reaction of methanol at 298 K.

b. Calculate the standard enthalpy of formation of liquid methanol ($\Delta H_f°$) at 298K, deduce the enthalpy of formation of gaseous methanol.

II. Calculate the bond energy (O-H) in gaseous methanol?

Data: at 298K: $\Delta H°_f\ (CO_{2\ (g)}) = -393$ KJ/mol, $\Delta H°_f\ (H_2O_{\ (l)}) = -285$ KJ/mol,
$\Delta H°_{Vap}\ (CH_3OH) = +39$ KJ/mol, $\Delta H°_{sub}\ (C) = +714$ KJ/mol

Bond	H-H	C-H	C-O	O=O
$\Delta H°_{diss}$ (KJ/mol)	436	415	350	464

Exercise 4:

Consider the following reaction at 298K:

$CH_4\ (g) + Cl_2\ (g) \rightarrow CH_3Cl\ (g) + HCl\ (g)$

1. Calculate the standard enthalpy of reaction $\Delta H_R°$ at 298K.
2. Calculate the bond energy of the C-H bond at 298K.
3. Calculate the standard molar enthalpy of sublimation of carbon at 298K.

Data:

$\Delta H_f°_{,298}(CH_4,g) = -17{,}9$ kcal/mol, $\Delta H_f°_{,298}\ (CH_3Cl,g) = -20$ kcal/mol, $\Delta H_f°_{,298}\ (HCl,g) = -22$ kcal/mol
$\Delta H°_{298}\ (Cl\text{-}Cl) = -58$ kcal/mol, $\Delta H°_{298}\ (C\text{-}Cl) = -78$ kcal/mol
$\Delta H°_{298}\ (H\text{-}Cl) = -103$ kcal/mol, $\Delta H°_{298}\ (H\text{-}H) = -104$ kcal/mol

Exercise 5:

Consider the following reaction:

$Fe_{(s)} + ½\ O_{2\ (g)} \longrightarrow FeO_{(s)}$

1. Calculate the standard enthalpy of reaction $\Delta H°_R$ at T_0=298 K.
2. Calculate $\Delta H°_R$ of the reaction at T_1=1700 K and T_2=1900 K, knowing that $\Delta H°_{fusion}(Fe)$=14.9 kJ/mol at T_f=1807 K.

Data: at 298K : $\Delta H°_f\ (FeO_{(s)}) = -272{,}04$ KJ/mol, $C_p\ (Fe_{(s)}) = 24{,}9$ J/K.mol, $C_p\ (Fe_{(l)}) = 46$ J/K.mol,
$C_p\ (O_{2\ (g)}) = 29{,}4$ J/K.mol, $C_p\ (FeO_{(s)}) = 49{,}70$ J/K.mol