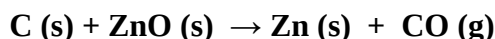


Series N°3

Exercise 1 :

Let the following reaction be carried out on 1 mole of zinc oxide ZnO at 25°C and under 1 atm:



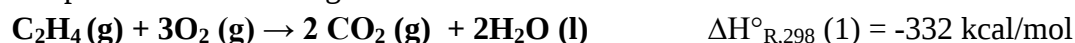
Considering that carbon monoxide CO behaves like an ideal gas, calculate:

- 1) The amount of heat Q at constant pressure.
- 2) The amount of heat Q at constant volume.

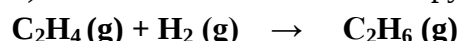
Data : At 25°C : $\Delta H^\circ_f(\text{CO}) = -110,3 \text{ KJ/mol}$; $\Delta H^\circ_f(\text{ZnO}) = -347,8 \text{ KJ/mol}$

Exercise 2 :

We provide the following combustion reactions under standard conditions:



- 1) Determine the standard enthalpy $\Delta H^\circ_{\text{R},298}(4)$ of the following reaction:



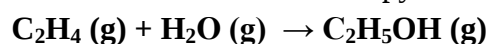
- 2) Calculate the enthalpy of formation of $\text{C}_2\text{H}_6(\text{g})$.
- 3) Determine the enthalpy of formation of the C-C bond in $\text{C}_2\text{H}_6(\text{g})$.

Data : $\Delta H^\circ_{\text{f},298}(\text{C}_2\text{H}_4, \text{g}) = 8,04 \text{ kcal/mol}$; $\Delta H^\circ_{\text{sublimation}}(\text{C}, \text{s}) = 171,2 \text{ kcal/mol}$

$\Delta H^\circ_{\text{f},298}(\text{H}-\text{H}) = -104 \text{ kcal/mol}$; $\Delta H^\circ_{\text{f},298}(\text{C}-\text{H}) = -99,5 \text{ kcal/mol}$

Exercise 3 :

Calculate the standard enthalpy of the following reaction:



- 1) from the standard molar enthalpies of formation.
- 2) from bond energies.
- 3) provide an explication for the found results.

Data :

$\Delta H^\circ_{\text{f},298}(\text{C}_2\text{H}_4, \text{g}) = 33,6 \text{ KJ/mol}$; $\Delta H^\circ_{\text{f},298}(\text{C}_2\text{H}_5\text{OH}, \text{g}) = -275,9 \text{ KJ/mol}$

$\Delta H^\circ_{\text{f},298}(\text{H}_2\text{O}, \text{g}) = -242,4 \text{ KJ/mol}$; $R = 8,314 \text{ J/mol.K}$.

bond	H-H	C-H	C-C	O-H	C-O	C=C
$\Delta H^\circ_{\text{f},298}(\text{bond}) (\text{KJ/mol})$	- 434,7	- 413,8	- 263,3	- 459,8	- 313,5	- 611,8

Exercise 4 :

The decomposition of oxalic acid $\text{C}_2\text{H}_2\text{O}_4$ occurs according to the following reaction:



- 1) Calculate the standard enthalpy of formation of $\text{C}_2\text{H}_2\text{O}_4(\text{s})$ at $T = 298 \text{ K}$.
- 2) Calculate the standard enthalpy of this reaction of $\text{C}_2\text{H}_2\text{O}_4(\text{s})$ at $T=298\text{K}$.
- 3) Calculate the internal energy change of this reaction at $T_1 = 298 \text{ K}$ and then at $T_2 = 400 \text{ K}$.

Data :

bond	H-H	O=O	C-C	C-O	C=O	O-H
$\Delta H^\circ_{f, 298(\text{bond})}$ (KJ/mol)	-434,7	-494,9	-345,3	-357,4	-727,6	-462,3

Compound	C ₂ H ₂ O ₄ (s)	H ₂ CO ₂ (l)	H ₂ CO ₂ (g)	CO ₂ (g)
c _p (J/mol.K)	105,9	99,0	45,7	37,2

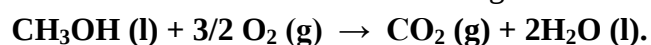
$$\Delta H^\circ_{\text{sub}} (\text{C}) = 718,4 \text{ KJ/mol} ; \Delta H^\circ_{\text{sub}} (\text{C}_2\text{H}_2\text{O}_4) = 248,2 \text{ KJ/mol}$$

$$\Delta H^\circ_f (\text{H}_2\text{CO}_2) = -409 \text{ KJ/mol} ; \Delta H^\circ_f (\text{CO}_2) = -397,3 \text{ KJ/mol}$$

$$\Delta H^\circ_{\text{vap}} (\text{H}_2\text{CO}_2) = 22,7 \text{ KJ/mol} ; T_{\text{vap}}(\text{H}_2\text{CO}_2) = 374 \text{ K}$$

Exercise 5 :

The complete combustion of one mole of liquid methanol under standard pressure and temperature conditions releases 725.2 kJ according to the following reaction:



1) Calculate the standard enthalpy of formation of liquid methanol.

2) Calculate the enthalpy of this reaction at 60°C.

3) Calculate the enthalpy of this reaction at 127°C and at one atmosphere pressure, knowing that at this pressure, methanol boils at 64,5°C and water at 100°C.

Data :

$$\Delta H^\circ_{f, 298} (\text{H}_2\text{O}, \text{l}) = -285,2 \text{ KJ/mol} ; \quad \Delta H^\circ_{f, 298} (\text{CO}_2, \text{g}) = -393,5 \text{ KJ/mol}$$

$$\Delta H^\circ_{\text{vap}, 373} (\text{H}_2\text{O}, \text{l}) = 44 \text{ KJ/mol} ; \quad \Delta H^\circ_{\text{vap}, 337,5} (\text{CH}_3\text{OH}, \text{l}) = 35,4 \text{ KJ/mol}$$

Compound	H ₂ O (l)	H ₂ O (g)	CH ₃ OH (l)	CH ₃ OH (g)	O ₂ (g)	CO ₂ (g)
c _p (J/mol.K)	75,2	38,2	81,6	53,5	34,7	36,4