

AP Chem - Unit 4 - Hess' law of constant heat summation

Review

The symbol for the standard heat of formation (also known as the standard enthalpy of formation) is ΔH_f or ΔH_f° where:

Δ indicates a change

H indicates enthalpy, which is only measured as a change, not as an instantaneous value

$^\circ$ indicates a standard enthalpy change for any reaction under standard conditions of temp and pressure 25°C, 1 atm, 1 Molarity

f means "formed" or that a compound is being formed from its component elements

$$\Delta H = -q$$

2 possible ways to solve Hess problems

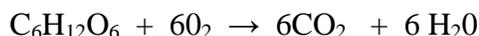
1. ΔH for a reaction is equal to the sum of the heats of formation of the product compounds minus the sum of the heats of formation of the reactant compounds:

$$\Delta H = \sum \Delta H_f \text{ products} - \sum \Delta H_f \text{ reactants} \quad (\text{note: } \Delta H \text{ can be } \Delta H_{\text{rxn}}, \Delta H_{\text{combustion}}, \text{ etc..})$$

2. ΔH is not dependent on Rxn Pathway
 - o Rxn reversed, sign of ΔH reversed
 - o If all coefficients of eqn multiplied or divided, same done to ΔH

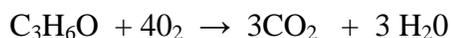
Problems

1. The heats of combustion for C, H₂, and CH₄ at 298 K and 1 atm are respectively -393 kJ/mol_{rxn}, -286 kJ/mol_{rxn} and -892 kJ/mol_{rxn}. What is the ΔH_f° for CH₄?
2. Calculate the standard enthalpy for the combustion of the following reaction:



ΔH_f°	kJ/mol
C ₆ H ₁₂ O ₆	-1275.0
CO ₂	-393.5
H ₂ O	-285.8
O ₂	0

3. Complete combustion of 1.00 mol of acetone (C₃H₆O) liberates 1790. kJ/mol_{rxn} (hint $\Delta H_{\text{Comb}}^\circ = -1790 \text{ kJ/mol}_{\text{rxn}}$)
Using the information (including table from problem #2. Calculate the enthalpy of formation of acetone:

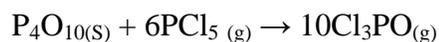


4. The standard enthalpy change, ΔH° , for the thermal decomposition of silver nitrate according to the following equation is +78.67 kJ/mol



The standard enthalpy of formation of $\text{AgNO}_3 (\text{s})$ is -123.02 kJ/mol. Calculate the standard enthalpy of formation of $\text{AgNO}_2 (\text{s})$

5. Calculate the value of ΔH° for the following reaction:



- a) $\text{P}_4 (\text{s}) + 6\text{Cl}_2 (\text{g}) \rightarrow 4\text{PCl}_3 (\text{g})$ $\Delta H^\circ = -1225.6 \text{ kJ/mol}_{\text{rxn}}$
b) $\text{P}_4 (\text{s}) + 5\text{O}_2 (\text{g}) \rightarrow \text{P}_4\text{O}_{10}(\text{s})$ $\Delta H^\circ = -2967.3 \text{ kJ/mol}_{\text{rxn}}$
c) $\text{PCl}_3 (\text{g}) + \text{Cl}_2 (\text{g}) \rightarrow \text{PCl}_5(\text{g})$ $\Delta H^\circ = -84.2 \text{ kJ/mol}_{\text{rxn}}$
d) $\text{PCl}_3(\text{g}) + \frac{1}{2} \text{O}_2 (\text{g}) \rightarrow \text{Cl}_3\text{PO}(\text{g})$ $\Delta H^\circ = -285.7 \text{ kJ/mol}_{\text{rxn}}$

6. The standard heat of combustion of benzene (C_6H_6) is -3271 kJ/mole_{rxn}. The standard heat of formation for CO_2 is -394 kJ/mol, and for H_2O , it is -286 kJ/mol. Calculate the ΔH°_f of benzene?