HW 7

Hess's Law states that the total enthalpy change of a chemical reaction is the same, regardless of the route by which the reaction takes place, provided the initial and final conditions are the same. This principle relies on the fact the enthalpy change depends only on the initial and final states, not on the path taken to get there.

Hess's Law Formula

If a reaction can be written as the sum of two or more steps, the enthalpy change of the reaction (ΔH_r) is the sum of the enthalpy changes of the individual steps:

$\Delta H_r = \Delta H_1 + \Delta H_2 + \cdots + \Delta H_n$

Example: Formation of Carbon Dioxide (CO_2)

Consider the reaction:

C(graphite)+O2(g)→CO2(g)

We can determine ΔH_r for this reaction using two hypothetical reactions:

Step 1: Formation of carbon monoxide (CO)

C(graphite)+12O2(g)→CO(g) ΔH1=−110.5 kJ

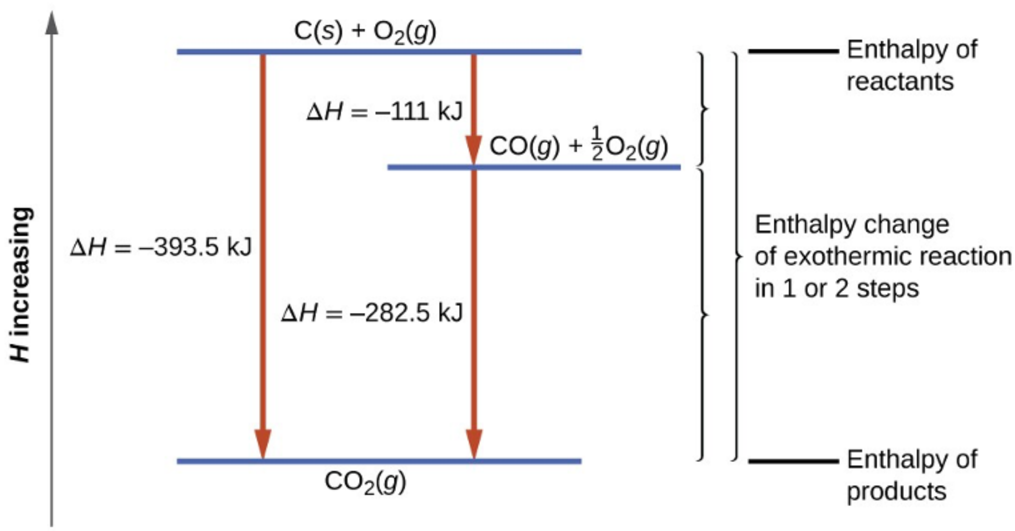
Step 2: Oxidation of carbon monoxide to carbon dioxide

CO(g)+12O2(g)→CO2(g) ΔH2=−283 kJ

Using Hess's Law, the enthalpy change for the overall reaction (formation of CO_2) is the sum of ΔH1and ΔH2

ΔHr =(−110.5)+(−283)=−393.5 kJ

Thus, the enthalpy change for the direct formation of CO_2 from C and O_2 is −393.5 kJ, which is the same regardless of the route taken. Look at the illustration:



Answer the following:

1. **How can you tell if a reaction is exothermic or endothermic based on enthalpy change?**
2. **If a reaction absorbs heat from its surroundings, is the enthalpy change positive or negative?**
3. **What is the difference between bond enthalpy and the enthalpy change of formation?**
4. Illustrate the following process (draw initial, final, intermediate steps and their corresponding enthalpy changes):
   BrF (g) + $2F_2$ (g) → BrF_5 (l) **Δ** H=- 400 kJ/mol

   BrF (g)+ F_2 (g) → BrF_3 (l) (g) **Δ** H=- 242 kJ/mol
   BrF_3 (gl+ F_2 (g) → BrF_5(l) (g) **Δ** H=- 158 kJ/mol