

Enthalpy

1. What is Enthalpy? What is its symbol?

A thermodynamic potential consisting of the internal energy of the system plus its pressure and volume. Due to the complexity of calculations that would be involved, we don't ever really deal with the enthalpy of a substance – rather we will perform calculations involving the changes in enthalpy during the course of a reaction.

Enthalpy is most clearly defined when the system is at constant pressure. When this is true, enthalpy is equal to q . This is why it is often referred to as the heat of reaction.

Enthalpy is represented by, H .

2. What is the equation for ΔH ?

The overall equation is

$$\Delta H = \Delta E + \Delta(PV)$$

If the reaction is under constant volume circumstances then the equation is rewritten

$$\Delta H = \Delta E + V\Delta P$$

If the reaction is under constant pressure circumstances then the equation is rewritten

$$\Delta H = \Delta E + P\Delta V$$

3. Under constant pressure circumstances what does ΔH equal?

When the reaction occurs under constant pressure circumstances then ΔH equals q_p . Where q_p is the heat energy of the reaction under constant pressure circumstances.

4. Is enthalpy a state function?

ΔH is a state function. Its formula is made up of various state functions.

5. Can enthalpy tell us whether a reaction is exothermic or endothermic? If so, how?

Yes – if the reaction is run under constant pressure.

If ΔH is negative the reaction is exothermic.

If ΔH is positive the reaction is endothermic.

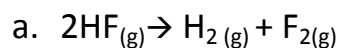
6. For the following, predict the relationship between ΔE and ΔH for the following reactions at constant pressure:

To determine how to answer this question, you must consider the equations

$$\Delta E = q + w$$

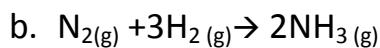
$$\Delta H = q_p$$

Remember that at constant pressure $\Delta H = q_p$. So if there is $+w$ done (i.e. a compression) then $\Delta E > \Delta H$ and if $-w$ (i.e. an expansion) is done then $\Delta E < \Delta H$.

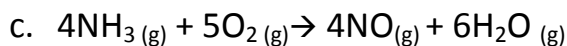


In this reaction the moles of gas on the product side equals the

moles of gas on the reactant side. This means that $\Delta V=0$. Because there is no change in volume, no work is done so, $\Delta H = \Delta E$.



In this reaction there are two moles of product and 4 moles of reactant. This means that this reaction underwent a compression. As was previously indicated, in a compression, there is positive work so, $\Delta H < \Delta E$.



In this reaction there are 10 moles of product and 9 moles of reactant. This means that this reaction underwent an expansion. As was previously indicated, in an expansion $\Delta H > \Delta E$.

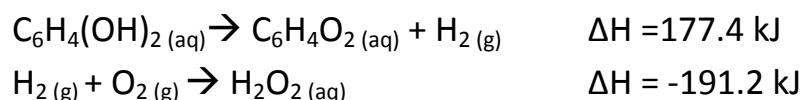
7. Hess' Law capitalizes on what property of enthalpy?

Hess' Law capitalizes on the state function status of enthalpy. You can use the enthalpy values of known reactions to find the ΔH of a new reaction.

8. How do the following changes to a reaction affect ΔH values?

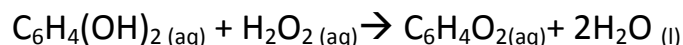
- a. Reverse of reaction \rightarrow Reverses sign of ΔH
- b. Multiplies reaction \rightarrow Multiply ΔH by the same constant
- c. Add up reactions \rightarrow add up the ΔH values for all reactions

9. Given

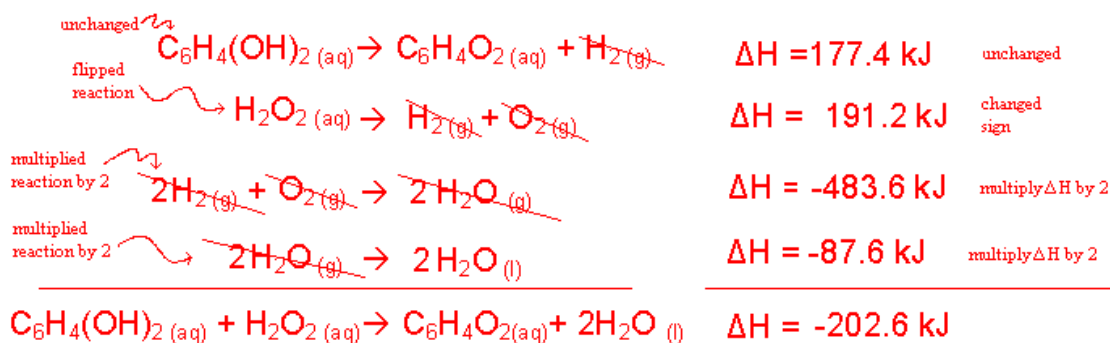




Determine ΔH for:



The goal here is to manipulate the equation given so that when they are added up they yield the reaction wanted. Each ΔH value is manipulated in similar manner so that a ΔH for the reaction can be determined.



10. This symbol ΔH°_f represents **standard enthalpy of formation**.

11. What is heat of formation?

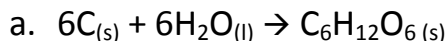
This is the enthalpy that accompanies the formation of a compound from its elements in their standard states (how they are naturally found).

12. What are the requirements to write out the heat of formation reaction equation for a molecule?

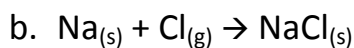
- a. **Only one mole of the compound is formed.**
- b. **The reactants must be pure elements in their standard state. For example, if we were looking at Mg – it would be a solid in its standard**

state, not a liquid.

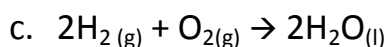
13. Which of the following represent a heat of formation reaction equation? If it is not correct, why?



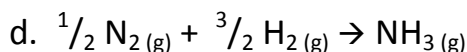
No. H_2O is a compound, not an element. Only elements are allowed on the reactant side.



No. $\text{Cl}_{(g)}$ is not the standard state for chlorine, $\text{Cl}_2_{(g)}$ is.



No. Only one mole of $\text{H}_2\text{O}_{(l)}$ is formed in a standard enthalpy of formation – not two.



Yes.

14. An element in its standard state has a ΔH°_f equal to **zero**. Why?

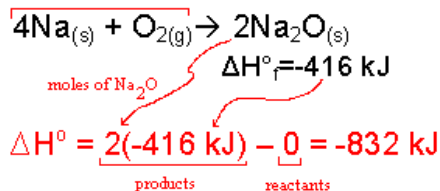
Because it does not take any energy to get them in their standard state. It's simply the way they come. Like $\text{O}_2_{(g)}$ or $\text{Hg}_{(l)}$.

15. The equation to derive the $\Delta H^\circ_{\text{rxn}}$ from ΔH°_f is:

$$\Delta H^\circ_{\text{rxn}} = \sum \Delta H^\circ_{f(\text{product})} - \sum \Delta H^\circ_{f(\text{reactant})}$$

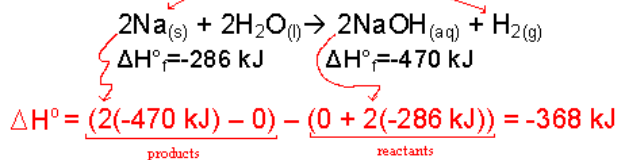
16. Calculate $\Delta H^\circ_{\text{rxn}}$ for the following:

both reactants are in their standard state
so both have an enthalpy of formation equal to zero.



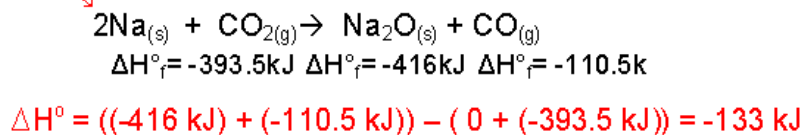
a.

in their standard state so
enthalpy of formation equal to zero.



b.

standard state so
enthalpy of formation equal to zero.



c.