

Thermochemical Equations and Calorimetry ANSWERS

A **Thermochemical equation** is simply a *balanced chemical equation* that also includes the change in energy that occurs in the equation. For example, the thermochemical equation for the synthesis of ammonia is:



The coefficients in the equation represent moles, so what this means is that if *1* mole of N_2 reacts with *3* moles of H_2 and *2* moles of NH_3 are produced, then 46.2 kJ will be given off.

But how can you tell that heat was released?

The ΔH of a reaction refers to the energy change that occurred in the reaction. The “ Δ ” means “change in” and the H refers to the “heat content” (also called “enthalpy”) of the chemicals.

ΔH is always the H of the products – H of the reactants.

If a reaction is **endothermic**, this means that the chemicals in the reaction absorbed heat from their surroundings, so that the products have more energy than the reactants. Since $\Delta\text{H} = \text{H}_{\text{products}} - \text{H}_{\text{reactants}}$, and in an endothermic reaction the products have more stored energy than the reactants (after all, they absorbed some heat), the ΔH will always be **positive** for an endothermic reaction. This makes sense because heat was added, so you would expect the change in heat content to be positive.

In the reaction at the top of the page, the ΔH is negative. This means that the reaction is **exothermic** and that as the reaction occurred heat was released to the surroundings. The reactants gave off heat energy, so the products must have less energy than the reactants. And since $\Delta\text{H} = \text{H}_{\text{products}} - \text{H}_{\text{reactants}}$ and since the products have less heat content than the reactants, the ΔH must always be **negative** for an exothermic reaction. This makes sense because the chemicals in the reaction lost heat.

Again referring to the thermochemical equation above, it tells us that when 2 moles of NH_3 are synthesized, 46.2 kJ are given off to the surroundings. What would be the ΔH if 2 moles of NH_3 were decomposed? Well, since 46.2 kJ are released when 2 moles of NH_3 are *formed*, then 46.2 kJ of heat would have to be *absorbed* in order to do the opposite. Thus, the ΔH for the reverse reaction would be +46.2 kJ.

How thermochemical equations are used:

Determining the amount of heat absorbed or released in a reaction.



Example: *Given the thermochemical equation above, determine how much heat would be released if only 1 mole of NH_3 was synthesized.*

Well, according to the thermochemical equation 46.2 kJ are released when 2 moles are synthesized, then half this—or 23.1 kJ—would be released when 1 mole of NH_3 is synthesized.

$$1 \text{ mole NH}_3 \times \frac{46.2 \text{ kJ}}{2 \text{ moles NH}_3} = 23.1 \text{ kJ}$$

You'll notice that the negative sign is not in front of the 46.2 kJ. The sign + or – only needs to appear in the thermochemical equation, nowhere else.

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