

CHEM 3410: Physical Chemistry I — Fall 2009

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Lecture 6: Thermochemistry and Phase Changes

References

1. Engel and Reid, *Physical Chemistry*, Sections 4.1–4.6

Key Concepts

- Enthalpy is a useful thermodynamic function because is directly related to the heat transferred at constant pressure:

$$\Delta H = q_p$$

- We can always figure out the heat transferred into/out of a system through the heat capacity. At constant pressure (where we are for most of our lives):

$$\delta q_p = C_p dT \rightarrow q_p = \int C_p dT$$

This relationship is useful and we can:

1. determine how much heat is needed to change the temperature of a system. Said another way, what the enthalpy change of the system is when the temperature is changed.
 2. determine how the temperature changes when a given amount of heat is added or extracted from a system
 3. or we can measure the enthalpies of reactions through the use of calorimetry
- Tabulated data of enthalpies of formation can be used to calculate the enthalpies of reactions occurring at 298 K. This is possible because enthalpy is a state function.
 - At non-standard temperatures we can also determine the enthalpies of reactions by using tabulated data from 298 K along with the heat capacities of the reactants and products. Again, this is possible because enthalpy is a state function. (See practice problem 1)
 - If a substance changes phase (solid to liquid, liquid to vapor, solid to solid) there is an associated change of enthalpy. For example, in going from solid to liquid there is an enthalpy of melting or fusion, which is a quantity of heat that needs to be supplied at the melting temperature to produce the phase change.
 - For example, if we wanted to calculate how much heat we needed to supply to a system of water to raise the temperature from 298 K to 500 K, we would need to consider the phase transformation of water that occurs at 373 K:

$$\Delta H_{total} = \int_{298}^{373} C_p^{liquid(H_2O)} dT + \Delta H_{vaporization}^\circ + \int_{373}^{500} C_p^{vapor(H_2O)} dT$$

Related Exercises in Engel & Reid

Exercises 4.14, 4.20