April-June 2019

Thermodynamics Project

Assignment
Subproject 2: enthalpy vs. entropy

The assignment for subproject 2 is to setup an experiment to measure the difference between enthalpy and entropy in a chemical reaction. There are two main goals in this assignment.
-*Firstly*, we want to register the effect of the change in enthalpy and entropy for a spontaneous reaction, and compare it to theory.
-*Secondly*, we want to get experience in setting up an experiment, through which claims can be made on parameters which are not directly measurable. How can you get as much information as possible about the change of entropy, within the limitations of this project.

***insight, innovatively* and *accuracy* will play a leading role in this subproject.**

We will do thermodynamic measurements on the dissolution/precipitation behavior of salts in water.
The experiments can or will be rather simple. Most of the time will be spent on the preparation, the choice of an appropriate experiment and estimating the measurement errors.

Quantities to be measured
Like all reactions at constant pressure and temperature, dissolution- and precipitation reactions are dictated by the Gibbs free energy $G = H - TS$.
We can study dissolution/precipitation behaviour of, in principle, the following salts.

$Mg(OH)_2$
$Mg(NO_3)_2$
$KClO_4$
$CaCO_3$
$MgSO_4$
$NaNO_3$
$Ca(OH)_2$
$Ca(NO_3)_2$
$Al_2(SO_4)_3$
KOH
K_2CO_3
$Ba(NO_3)_2$
$BaCO_3$
$CaSO_4$

Scheme
The subproject consists of 5 phases.
Make a good time plan so that you have enough but need not too much time for each of the following phases.

Phase 1: preparation by each couple separately

-Choose reactions and experiments for a number of the salts in the table; choose both sparsely soluable and well soluable salts.

-Design suitable experiments to get as much qualitative and quantitative information on the enthalpy and entropy changes; be aware of safety, feasibility and sensitivity for the parameters to be measured.

Phase 2: Preparation by whole group

The choices and considerations of the couples will then be exchanged in the presence of the assistant. The final goal, achievability and distribution of tasks will follow from this discussion. The aim is to have different couples performing different experiments. The assistant will point out what equipment and chemicals are actually available.

Phase 3: Experiments by the couples individually

The couples will, if necessary, conduct a couple of test experiments, in which they try different reactions. The quantitative experiments which seem feasible will be chosen. The pairs will then build up and conduct the experiment.

Before conducting the experiment, the assistant has to give permission for safety reasons.

Phase 4: Report to the group

After the experiments the next step is: share the results of each couple with the rest of the group. If necessary, it can be discussed how to cope with disappointmenting results to still be able to write a sensible report.

Phase 5: Writing the report by the couples

The couples should write the report during scheduled project hours.

The report is to be handed in to the assistant at the beginning of the next subproject.
If this is not possible, a new date has to be discussed for both handing in and evaluation.