April-June 2019

Thermodynamics Project

Assignment
Subproject 1: energy vs. enthalpy

The assignment for subproject 1 is to setup an experiment to measure the difference between internal energy and enthalpy in a chemical reaction. There are two main goals in this assignment.
-*Firstly*, we want to get a feeling for how big the difference is between an isobaric- and a isochoric reaction. The difference will generally turn out to be fairly small compared to the change in energy of the reaction.
-*Secondly*, we want to use that small difference to get an experience for performing experiments on the edge of measureability. How do you set up an experiment to measure such low values with reasonable accuracy.

***Measurability, feasibility* and *accuracy of the measurements* will play a leading role in this subproject.**

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.
The small difference between the enthalpy and internal energy will make the measurement quite difficult. Don't let this discourage you. After all, the main goal is to get a feeling for accuracy and setting up an experiment that is as accurate as possible, given the available equipment and chemicals.

The choices you make for an accurate and practical experiment outweigh the results of the experiment.

Quantities to be measured
The difference between the internal energy U and the enthalpy H can be found with the following equations:

Energy: $\mathrm{d}U = \mathrm{d}Q + \mathrm{d}W$ with Q the heat and $\mathrm{d}W = -P_{ext}\mathrm{d}V$ the work
Enthalpy: $\mathrm{d}H = \mathrm{d}U + \mathrm{d}(PV)$

The difference is in the terms $V\mathrm{d}P$ and $P\mathrm{d}V$, at least for a reversible reaction. Note, that a reversible reaction is difficult to perform.

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
-Come up with reaction for which the difference between internal energy and enthalpy are optimally expressed in a doable experiment.

-Make a quantitative estimate of the difference between internal energy and enthalpy for that reaction.
-Come up with an appropriate setup to measure the difference between internal energy and enthalpy and consider the safety, feasibility and accuracy for measuring the relevant parameters.

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 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 couples will then build up and conduct the experiments.
Before conducting the experiments, 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 disappointing results to still write a sensible report.

Phase 5: Writing the report by the couples

The couples should write the report during the 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.