April-June 2019

Thermodynamics Project

Assignment
Subproject 3: electrochemistry

The assignment for the third subproject is to design, build and test a pH meter.
There are two main goals in this assignment.
-*Firstly*, we want to test the Nernst equation, which forms the thermodynamic basis of electrochemistry. Our setup will be as elementary as possible.
-*Secondly*, we want to expand our experience in setting up experiments in electrochemistry.

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

We will conduct the experiments by acid-base titrations, to calibrate the pH meter. The experiments will require sufficient tidiness and accuracy. In order to make a judgement of the accuracy of the pH meter, an estimate of the measurement errors will have to be made.

Available equipment and reactions
The available equipment is limited to standard hydrogen electrodes, calomel electrodes, mV/pH-meter, glassware and titration apparatus.
The existing pH-meters can of course only be used to make an estimate of the accuracy and/or calibration.
Multiple acids and bases (weak, strong, polyvalent) can be used for the acid-base reaction. The challenge is to measure a great variety of acids and bases per group, and that those are equally divided over the pairs.

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
-Design a suitable experimental setup, within the limits of the available equipment, to be able to measure the pH as accurately as possible on the basis of Nernst's law.
-Be aware of safety issues (hydrogen gas), feasibility and sensitivity for the parameters to be measured.
-Make an estimate in advance of the expected potentials for reasonable concentrations of chemicals.
-Determine which further parameters play a role in the experiments.

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 do different experiments. The assistant will point out what equipment and chemicals are available.

Phase 3: Experiments by the pairs individually

The pairs 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 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 pair with the rest of the group. If necessary, it can be discussed how to process the disappointing results to still write a sensible report.

Phase 5: Writing the report by the pairs

The pairs should write the report during the scheduled project hours.
The report is to be handed 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.