Chemistry 254
Experiment 8
Thermodynamics of a chemical cell

Adam Menne
Stellenbosch University

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Abstract

In this practical the temperature dependence of cell potential in a chemical cell was investigated, with a focus on the thermodynamic properties responsible for this dependence.

Contents

1 Introduction

In this practical we investigate the temperature dependence of emf in a standard button cell, by fitting a linear regression to empirical data. From the linear regression, we extract the necessary quantity to calculate various thermodynamic properties of the cell reaction.

2 Results

The fit on the linear regression has a percent error of 0.001543 and 4.994e-6 for the intercept and slope respectively. This indicates, atleast approximately, a linear relationship between emf and temperature. See figure 1

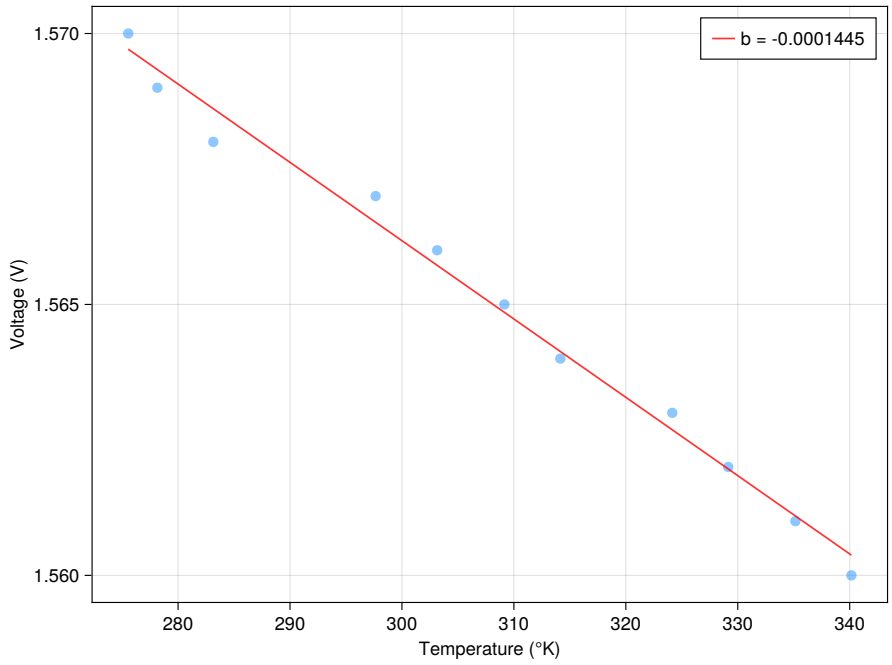

Figure 1: Voltage over temperature, with linear regression

At room temperature (24.5 ℃), the cell had an emf of 1.567 (V), the predicted result from the linear regression is 1.5665... (V). The percent error is 0.03087.

Our empirical value for enthalpy matches well with known values for the cell reaction in question. However the value for entropy are less in line with the

Table 1: Thermodynamic properties

	Empirical	Standard
ΔH $(kJ\ mol^{-1})$	-308.4	-319.4
ΔS $(J\ K^{-1}\ mol^{-1})$	-27.89	-76.6

expected value. See table 1

A static export of the notebook containing all analysis and figures is availible at `https://adammenne.github.io/chemistry_254/practical_1/plots.html`. With full source code availble at `https://github.com/AdamMenne/chemistry_254/tree/master/practical_1`

3 Discussion

One alteration to the experimental procedure was made. Due to the limited resolution of the multimetres used, and the heated water bath not reaching the desired temperatures, the number of data points that were sampled were, if not inadequate, undesirable. To gather a larger number of data points, we exposed the cells to a larger temperature range by placing the oil bath in an ice-water slurry, allowing the cell to be cooled to a temperature of 2.4 ℃, pushing the number of data points from 8 to 11.

The small value for percent error for emf at room temperature is a result of a few factors, partly as can be seen in figure 1, there is a periodic trend of datapoints being in clusters, the first three, and next two groups of four, all appear to express a perfectly linear relationship between emf and temperature. However these clusters are shifted relative to each other. This is likely due to rounding errors introduced by the multimetre. As such it is mostly coincidence that the datapoint at room temperature happens to lie almost perfectly on the regression line.

The mismatch between the expected and known value for entropy of the cell reaction, is the largest discrepancy in this report, and is in all likelyhood due to an error in calculation.