

Determining the effect of electrolyte concentration of the voltage produced by galvanic cells

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1 Rationale

1.1 Background

Redox

Redox reactions are reactions that involve the transfer of electrons between atoms. These reactions commonly occur within galvanic cells, which within themselves contain two half cells.

Half Cells

Half cells consists of an electrolyte solution and electrode. When two are connected through a load and a salt bridge, one of these half cells will become the anode, where oxidation occurs, and the other will become the cathode, where reduction occurs.

The oxidised cell will transfer its electrons across a wire, where they will then reach and be accepted by the reduced cell.

Each cell has its own standard electrode potential (E^0) which dictates the magnitude of electron emission, or attraction it has under standard lab conditions.

By measuring the difference in magnitude between cells, the overall potential between the cells can be quantified.

$$E^0_{\text{Cell}} = E^0_{\text{Cathode}} - E^0_{\text{Anode}}$$

What is the result of this?

Why does this happen

2 Methodology

2.1 Modifications

Half Cell Compositions

The results of original experiment indicated that copper and aluminum produced the largest voltage. It was theorized that after multiple trials, the aluminum would oxidise, skewing results.

It was decided that copper and zinc would be more suitable as although they produced a smaller voltage, zinc would take longer to oxidise and therefore produce more consistent results.

Electrodes

Rather than thin strips, larger plates were bent into a "C" shape, slightly smaller than the diameter of the beaker they would be placed in. This maximised the surface area in contact with the electrolyte solution. Furthermore by resuing the same electrodes, this surface area was constant for all trials.

The original method is attached as an appendix

2.2 Method

Materials

- 30ml CuSO_4 at concentrations 1.00M, 0.85M, 0.70M, 0.55M, 0.40M, 0.30M, 0.20M, 0.10M
- 240ml 1M ZnSO_4
- 20ml KNO_3
- Petri dish
- 50ml Beaker - x2
- zinc sheet $\approx 4\text{cm} \times 6\text{cm}$
- copper sheet $\approx 4\text{cm} \times 6\text{cm}$

- Emery paper
- Filter paper strips $\approx 2\text{cm} \times 10\text{cm}$
- Digital Multimeter
- Alligator clips
- 150ml Plastic bottle - x16
- Tweezers
- 1L Distilled water
- Emery paper

Procedure

1. Pour varying amounts of $CUSO_4$ into 150ml plastic bottles and dilute with distilled water to form solutions with concentrations 1.00M, 0.85M, 0.70M, 0.55M, 0.40M, 0.30M, 0.20M and 0.10M.
2. Fill 8 of the 150ml plastic bottles with 30ml of 1M $ZnSO_4$ and set aside with copper solutions.
3. Polish electrodes with emery paper until they are shiny on all surfaces and then connect to alligator clips.
4. Connect alligator clips to multimeter and set to DC voltage mode.
5. Transfer the contents of a $CUSO_4$, and $ZnSO_4$ container into separate beakers.
6. Wet salt bridge with KNO_3 and rest over the lip of both beakers, so that it is partially submerged in both.
7. Add the electrodes to the solution and record result as soon as value settles.
8. Remove electrodes immediately and wash with distilled water. Stir electrolyte solutions with a glass stir rod. Remove salt bridge and dispose.
9. Reconstruct cell with a new salt bridge, add electrodes back, and repeat measurement so that there are three trials in total for any given concentration.
10. Safely dispose of electrolyte solutions, wash equipment, and repeat for next $CUSO_4$ concentration.

2.3 Risk assessment

Insert risk assessment

3 Results

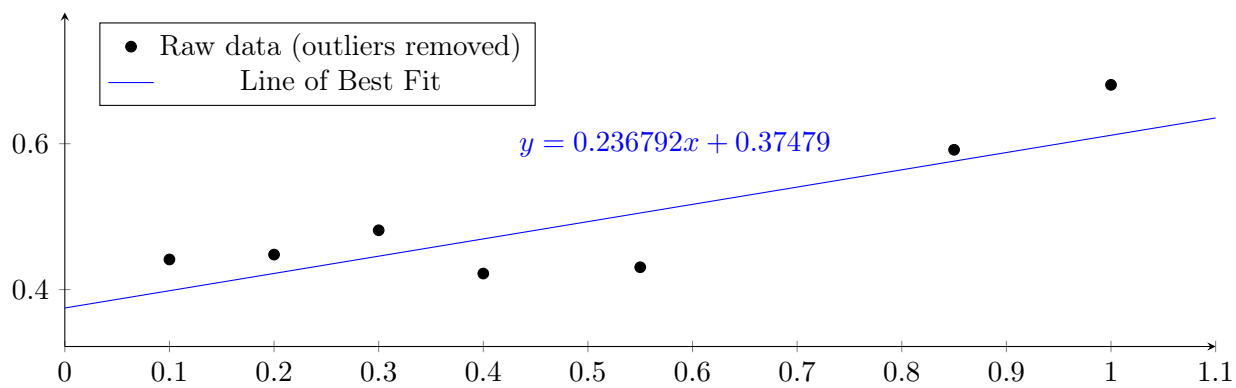


Figure 1: Raw results with outliers removed with line of best fit.

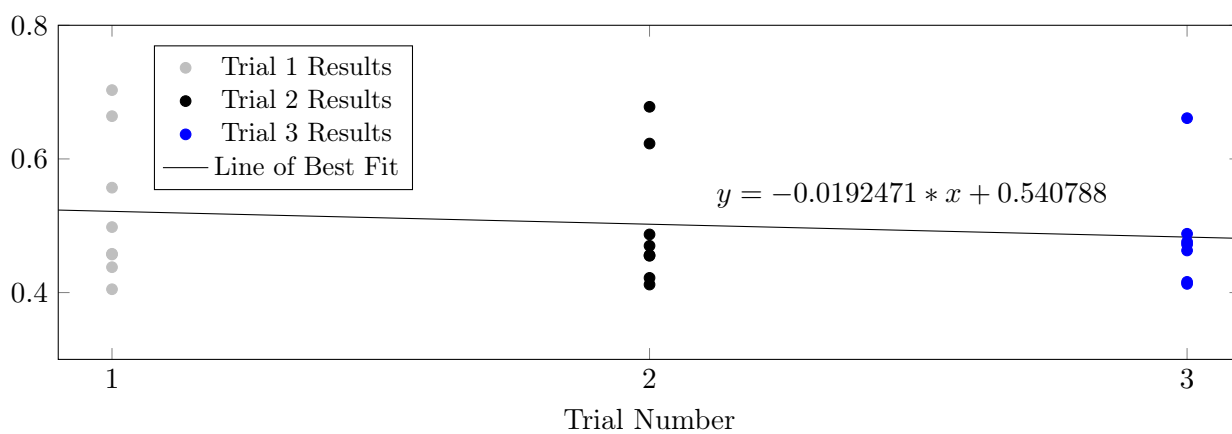


Figure 2: Line of best fit for voltage over sequential trials