

Experiment 6

Synthesis und Analysis of ein Magical Green Crystal

Part Deux: Oxalate Content Analysis by Redox Titration Using
a Vile Purple Fluid

CH 204 Fall 2009

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But first...

Last week:

Synthesis of $K_x[Fe_y(C_2O_4)_x] \cdot zH_2O$

Coordinate covalent bonds and metal complex ions

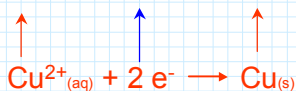
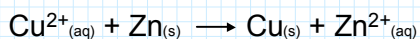
Calculating limiting reagent, theoretical yield,
and percent yield

This week:

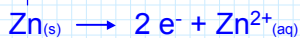
Oxidation-Reduction (Redox) chemistry

What is redox chemistry?

Moving electrons between different atoms:



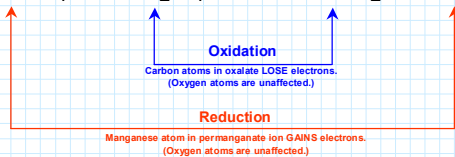
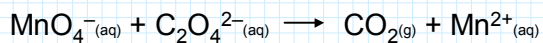
Cu^{2+} gains electrons.
 Cu^{2+} is REDUCED.



$Zn_{(s)}$ loses electrons.
 $Zn_{(s)}$ is OXIDIZED.

Our redox reaction

MnO_4^- oxidizes the carbon in the oxalate ions surrounding the Fe^{3+} . The oxalate changes from $\text{C}_2\text{O}_4^{2-}$ to $\text{CO}_2(\text{g})$.



Hey! This reaction is not balanced!

Balancing redox reactions

Separate the overall equation into two half-reactions. For each half-reaction:

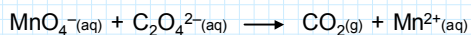
1. Balance the main atom.
2. Add H_2O to balance O.
3. Add H^+ to balance H.
4. Balance the charge using electrons.
5. Equalize electrons between the half-reactions.

Then add the two half-reactions, cancel out the electrons, and you're done!

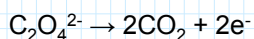
Let's try a few. To the Doc Cam!

Oxidation half-reaction

Here's our overall reaction again:

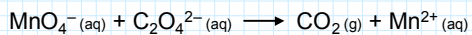


Oxidation of $\text{C}_2\text{O}_4^{2-}$ to CO_2 is simple enough:

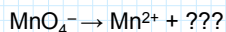


Reduction half-reaction

Overall reaction:



The oxidizing agent, MnO_4^- , gets reduced to Mn^{2+}



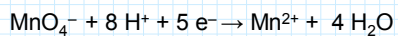
Balance Mn

Balance O using H_2O

Balance H using H^+

Balance charge using e^-

Reduction half-reaction solved!



Balance Mn

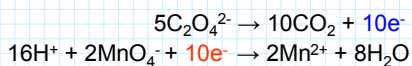
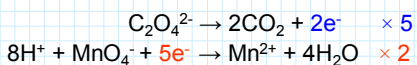
Balance O using H_2O

Balance H using H^+

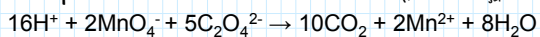
Balance charge using e^-

Add the two half reactions

First multiply the equations in order to equalize the electrons between the two half-reactions:



The equation for the overall reaction is:



Es gibt keine Elektronen, ja?
They all cancel out!
Saher gut?
Ja, sehr gut!

Always balance in acidic solution

Balancing redox half-reactions is as easy as 1-2-4.

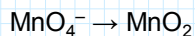
- 1) Balance the main atoms
- 2) Balance oxygens using H_2O
- 3) Balance hydrogens using H^+
- 4) Balance charge using e^-

What if the solution is basic?

Always balance the equation in acidic solution,
and if it's supposed to be in basic solution,
just add one OH^- to both sides for each H^+ in the reaction.

Just like this...

Permanganate is reduced to manganese (IV) oxide in basic solution:

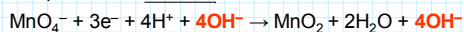


Balance O using H_2O : $\text{MnO}_4^- \rightarrow \text{MnO}_2 + 2\text{H}_2\text{O}$

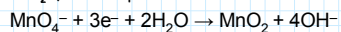
Balance H using H^+ : $\text{MnO}_4^- + 4\text{H}^+ \rightarrow \text{MnO}_2 + 2\text{H}_2\text{O}$

Balance charge using e^- : $\text{MnO}_4^- + 3e^- + 4\text{H}^+ \rightarrow \text{MnO}_2 + 2\text{H}_2\text{O}$

We got 4 H^+ , so add 4 OH^- to both sides!



4 H^+ + 4 OH^- \rightarrow 4 H_2O , so delete spectator water molecules:



Today: Sample prep and three titrations

Land mine! 1:1 mixture of ethanol/water means mix them together in a beaker **BEFORE** you pour them in!

The KMnO_4 solution is already standardized and ready to go.

Make sure you record the concentration: **0.0368 M**.

Take only about 50 ml of KMnO_4

Valuable time-saving tips!

Step 10: Start titrating while the sample is heating -- don't wait for 40°

Step 12: You are waiting two minutes for the purple color to go away. As soon as it goes away, start titrating again.

Step 13: In the titration, the solution starts out yellow and fades to colorless before it reaching the endpoint. As long as it's still yellow, you still have a ways to go.

Final Exam Time

We're past the halfway mark.

Next week —

Final Exam Part 6: Balancing redox reactions

(like post-lab problems 2 and 3),

and a redox reaction stoichiometry problem

(like post-lab problems 4 and 5).
