

Experiment 6

Synthesis und Analysis uff ein Magical Green Crystal

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

CH 204 Spring 2008

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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

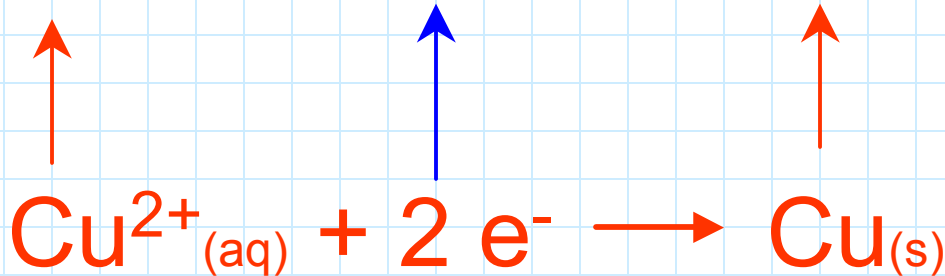
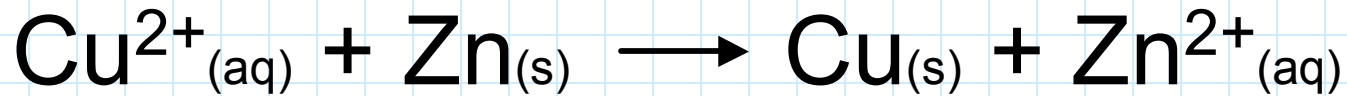
Calculating limiting reagent and theoretical yield

This week:

Oxidation-Reduction (Redox) chemistry

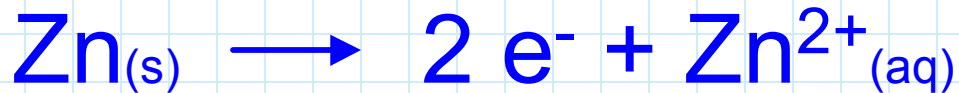
What is redox chemistry?

Moving electrons between different atoms:



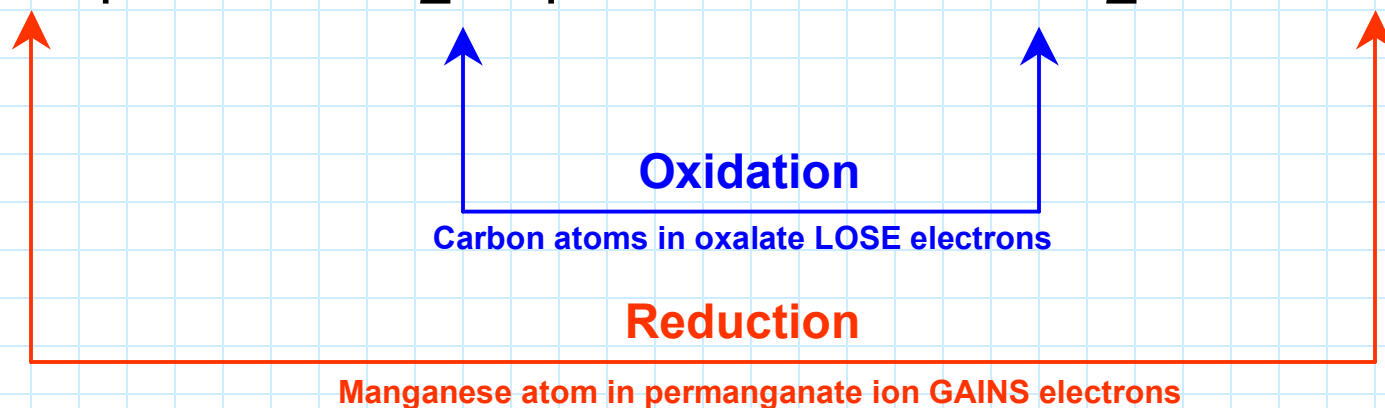
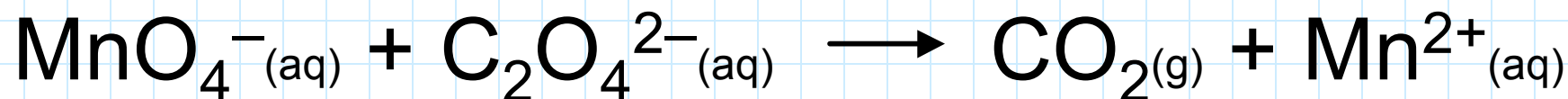
Cu^{2+} gains electrons.
 Cu^{2+} is REDUCED.

$\text{Zn}_{(\text{s})}$ loses electrons.
 $\text{Zn}_{(\text{s})}$ is OXIDIZED.



Our redox reaction

We will use MnO_4^- to oxidize the oxalate ligands surrounding the Fe^{3+} . The carbon in the oxalate ions will be oxidized, and the oxalate will change 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:

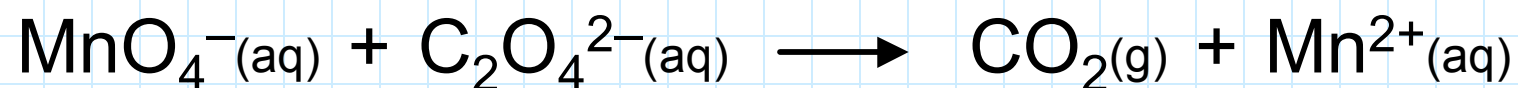
1. Balance the main atom.
2. Add H_2O to balance O.
3. Add H^+ to balance H.
4. Balance the charge using electrons.
5. Equalize electrons between the half-reactions.

When you're done, add the two half-reactions and cancel out the electrons.

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

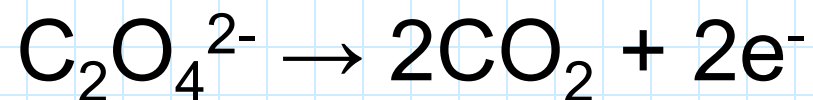
Oxidation half-reaction

Here's our overall reaction again:



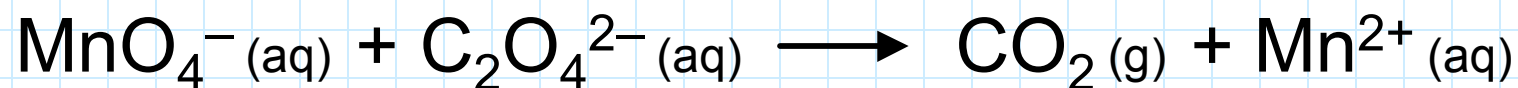
Oxidation of $\text{C}_2\text{O}_4^{2-}$ to CO_2 is simple enough:

(Remember, half-reactions do not include the other reactant)



Reduction half-reaction

Overall reaction:



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



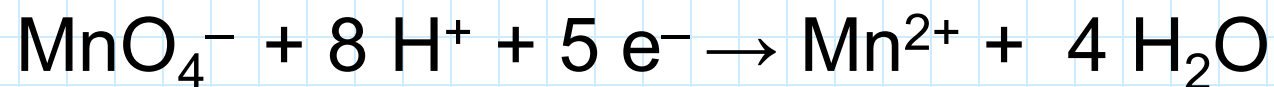
Balance Mn

Balance O using H_2O

Balance H using H^+

Balance charge using e^-

Reduction half-reaction solved!



Balance Mn

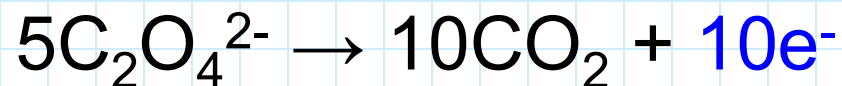
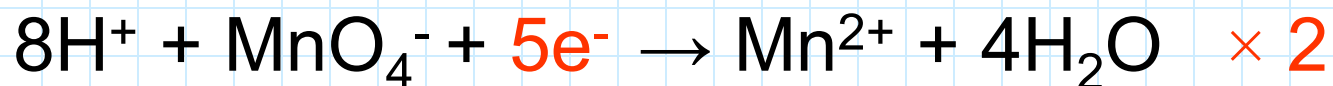
Balance O using H_2O

Balance H using H^+

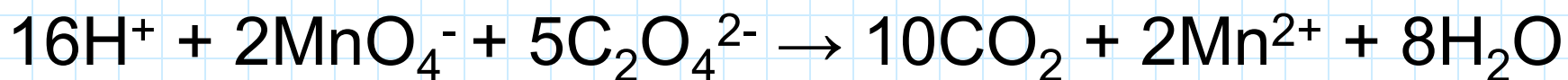
Balance charge using e^-

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!

Sehr gut?

Ja, sehr gut!

Always balance in acidic solution

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

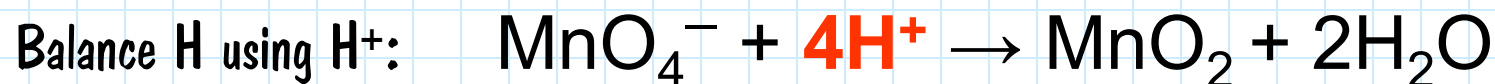
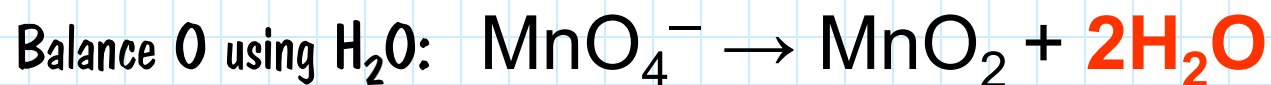
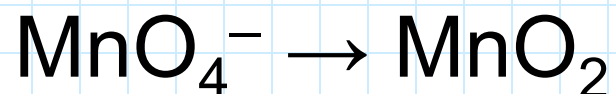
- 1) Balance the main atoms
- 2) Balance oxygens using H_2O
- 3) Balance hydrogens using H^+
- 4) Balance charge using e^-

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...

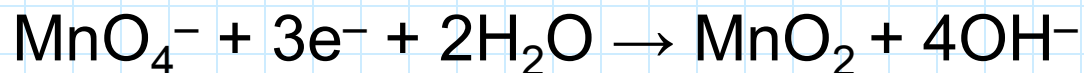
Permanagante is reduced to manganese (IV) oxide **in basic solution**:



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



4 $\text{H}^+ + 4 \text{OH}^- \rightarrow 4 \text{H}_2\text{O}$, so delete spectator water molecules:



Balancing redox reactions review

- Separate the reactants into half reactions.
- Balance the main atom.
- Balance the half-reactions using H_2O to balance O, then use H^+ to balance H. Balance the charge with electrons.
- Equalize electrons and add the two half-reactions — electrons must cancel.
- If necessary, convert acidic solution to basic by adding OH^- to both sides and crossing out 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: **0.0376 M**.

Take only about 50 ml of KMnO_4

Step 10: Start titrating while the sample is heating -- don't wait for 70°

Solution goes from yellow to colorless to endpoint.

Quiz Time

Mini-Final part 5 of 9 — we're past the halfway mark.

You will have a quiz covering redox chemistry when you return from spring break.