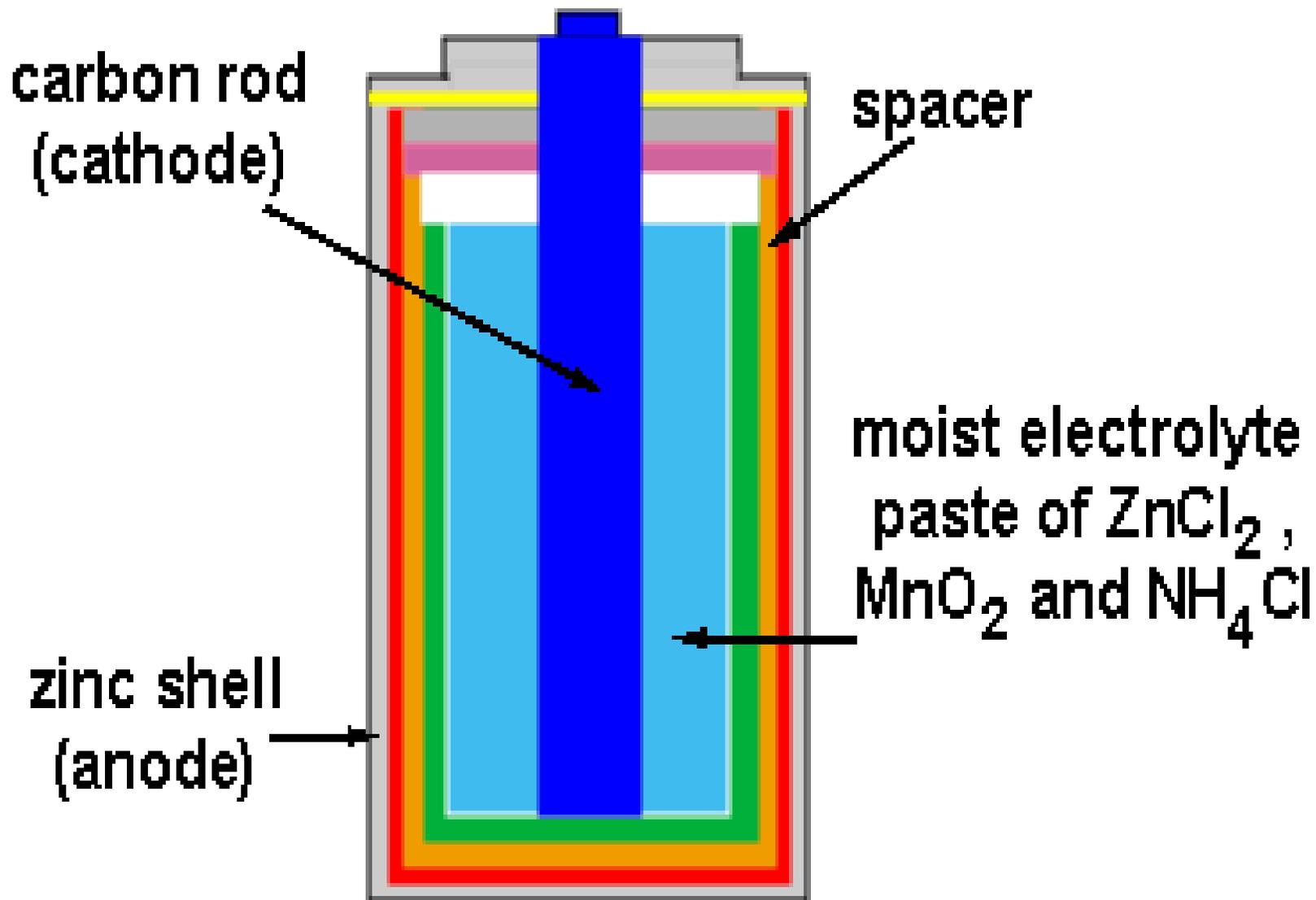


N42 - Electrochemistry

Concepts

Electrochemistry



Mnemonics

LEO goes GER

Loss of Electrons is Oxidation

Gain of Electrons is Reduction

OIL RIG

Oxidation is Loss of Electrons

Reduction is Gain of Electrons



Examples

Oxidation



Reduction



Oxidation Numbers

The charge an atom in a compound would have if the compound was composed of ions.

Helps track how the electrons are moving around during a reaction.

Sometimes easy to determine, sometimes complex.



Rules for Assigning Oxidation Numbers

1. Any uncombined element is 0.
2. Monatomic ion equals the charge on the ion.
3. The more-electronegative element in a binary compound is assigned the number equal to the charge it would have if it were an ion.
4. Fluorine in a compound is always -1
5. Oxygen is -2 unless it is combined with F, when it is +2, or it is in a peroxide, such as H_2O_2 , when it is -1

6. Hydrogen in most of its compounds is +1 unless it is combined with a metal, in which case it is -1
7. In compounds, the elements of groups 1 and 2 as well as aluminum have oxidation numbers +1, +2 and +3 respectively.
8. The sum of the oxidation numbers of all atoms in a neutral compound is 0.
9. The sum of the oxidation numbers of all atoms in a polyatomic ion equals charge of the ion.

Balancing Redox Equations

More complicated than balancing normal reactions.

You have to balance the electrons, not just the atoms!

Steps

1. Assign oxidation numbers to determine which things are oxidized and which are reduced.
2. Split the rxn into two halves – oxidation half and reduction half. Include electrons.
3. Balance the atoms.
4. Balance the charge by balancing the number of electrons.
5. Add half reactions back together, simplify, and CHECK.

Balancing Redox Reactions

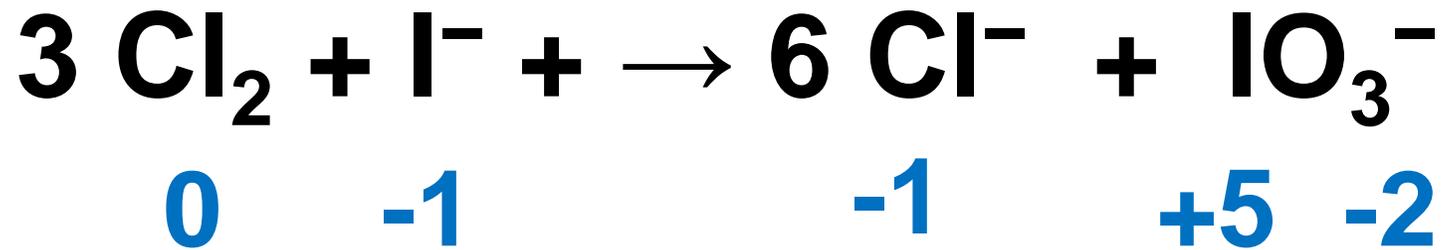
Yes, I know this isn't balanced!
That is what we are working on!

1

Assign oxidation states

Determine the element oxidized and the element reduced.

oxygen -2, not in one of the exceptions.



elements
are 0

monoatomic
ions match
their charge

monoatomic
ions match
their charge

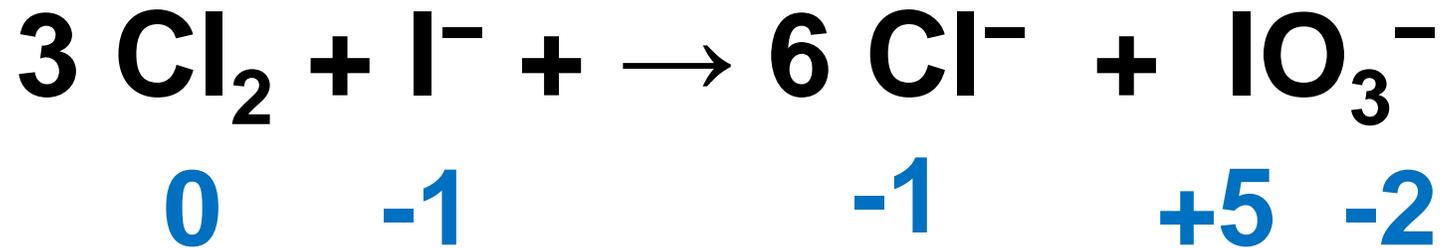
$x + -2 = -1$
sum must equal the
overall charge on ion
 $x = +5$

Balancing Redox Reactions

1

Assign oxidation states

Determine the element oxidized and the element reduced.



LEO goes GER

I⁻ lost electrons = oxidized, -1 → +5

Cl gained electrons = reduced, 0 → -1

Balancing Redox Reactions

2

Write oxidation and reduction half-reactions, including electrons

Oxidation electrons being lost, products

Reduction electrons being gained, reactants

Yes, I know these are not balanced! That is what we are still working on! It takes a while!

I⁻ went from -1 → +5, that's a loss of...



Cl₂ went from 0 → -1 for each Cl, that's a gain of...

Balancing Redox Reactions

3

Balance the atoms in the half reactions

- First balance elements other than H and O.
- Add H₂O where O is needed.
- Add H⁺ where H is needed



Balancing Redox Reactions

4

Balance the charge by balancing the # of e⁻

- Balance electrons between half-reactions.
Least Common Multiple

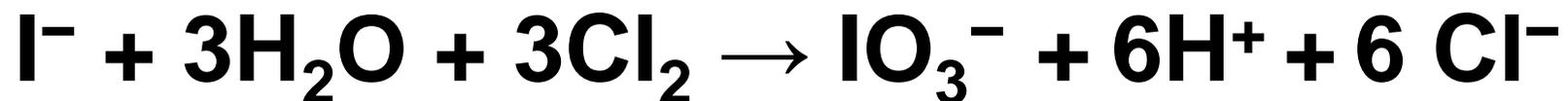
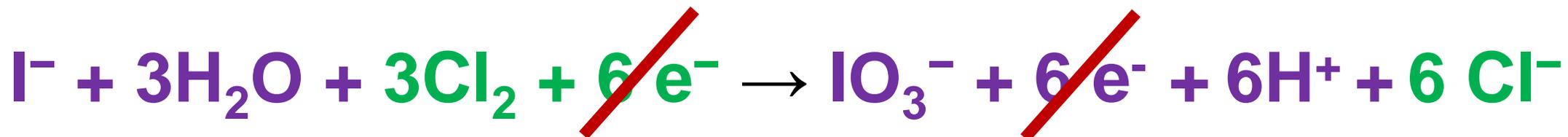


Balancing Redox Reactions

5

Add half reactions together, simplify, check

- Make sure the atoms balance AND the charges



CHECK: Atoms balanced – yes! Charges balanced – yes!

Best Advice...

USE PENCIL!

DON'T CRAM YOUR WORK! USE LOTS OF SPACE!

DON'T PANIC!

STUCK??? ERASE AND START OVER.

Oxidation and Reduction Recap

Oxidation is the process that occurs when

- the oxidation number of an element increases,
- an element loses electrons,
- a compound adds oxygen,
- a compound loses hydrogen, or
- a half-reaction has electrons as products.

Reduction is the process that occurs when

- the oxidation number of an element decreases,
- an element gains electrons,
- a compound loses oxygen,
- a compound gains hydrogen, or
- a half-reaction has electrons as reactants.

A Few More Electrochemistry Terms

Oxidizing agent

The substance that is doing the oxidizing of the other substance. Whichever substance is reduced is the oxidizing agent.

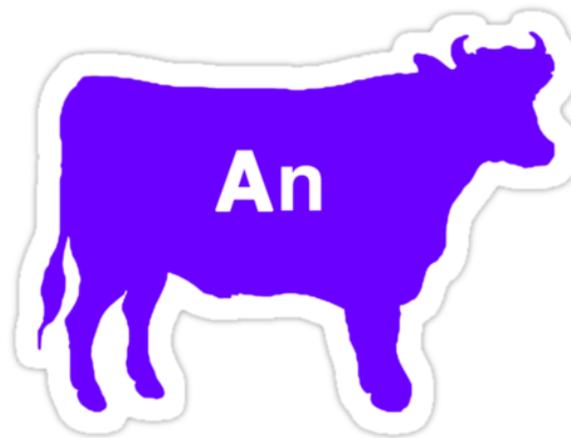
Reducing agent

The substance that is doing the reducing of the other substance. Whichever substance is oxidized is the reducing agent.

A Few More Electrochemistry Terms

Anode

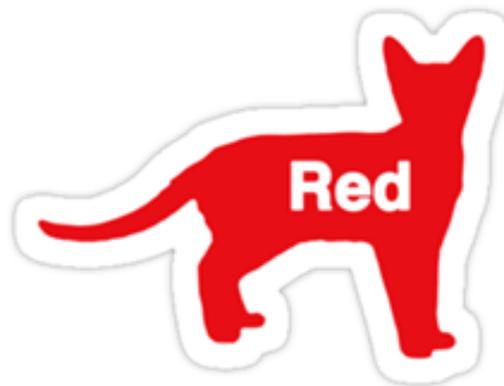
The electrode where oxidation occurs



Anode
is
Oxidation

Cathode

The electrode where reduction occurs



Reduction
at the
Cathode

A Few More Electrochemistry Terms

Current - the number of electrons that flow through the system per second.

- Unit = ampere, amp, A

$$1 A = \frac{1 \text{ Coulomb}}{1 \text{ second}} = \frac{6.242 \times 10^{18} e^{-}}{1 \text{ second}}$$

Electrode surface area dictates the # of e- that can flow.

- Larger batteries produce larger currents.

A Few More Electrochemistry Terms

The difference in potential energy between the reactants and products is the **potential difference**

- Unit = volt

1 V = 1 J of energy per coulomb of charge

The voltage needed to drive electrons through the external circuit

The amount of force pushing the electrons through the wire is called the **electromotive force, emf.**

Useful Conversions

$$1 A = \frac{1 \text{ Coulomb}}{1 \text{ second}} = \frac{6.242 \times 10^{18} e^{-}}{1 \text{ second}}$$

$$1 \text{ Volt} = \frac{1 \text{ Joule}}{1 \text{ Coulomb}}$$

$$1 \text{ Faraday} = \frac{96,500 \text{ Coulombs}}{1 \text{ mol } e^{-}}$$

Example: How many minutes does a 4.00 A current need to be applied to a Cu^{2+} solution to make 15.00 g of Cu?

15.00g	1 mol	2 mol e-	96,500 C	1 s	1 min	= 189.8 min
	63.55 g	1 mol Cu	1 mol e-	4 C	60 s	