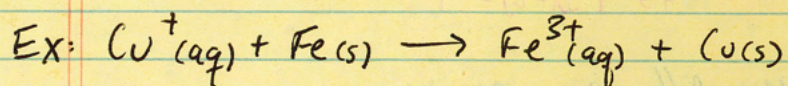


Redox Reactions: Types of Reactions

Def: An oxidative-reduction (redox) reaction is a chemical reaction where a transfer of electrons occurs between 2 species.



Electrons transferred from Fe \rightarrow Cu. How can we formalize this to reactions where this may not be obvious?

Def: Oxidation states/numbers describe the degree of oxidation of an atom in a chemical species. More practically, they are the hypothetical charge that an atom would have if all bonds to atoms of different elements were 100% ionic.

Remark: Oxidation states are typically integers (\mathbb{Z}), though rational oxidation states exist (as averages in a compound)

Remark: The sum of oxidation states in a compound should equal the overall charge of the compound. Neutral species have a total oxidation sum of 0. Ionic species sum to their charge.

Rules of Assigning Oxidation States:

- 1) Oxidation states of an individual atom is 0.
- 2) Group 1 elements have oxidation states of +1. Group 2 elements are +2.
- 3) The oxidation state of F is -1 in compounds
- 4) Hydrogen typically has a +1 oxidation number.
- 5) Oxygen typically has a -2 oxidation number.

Examples: a) Fe(s), 0
 b) $\text{O}_2(\text{g})$, 0
 c) $\text{Fe}_2\text{O}_3(\text{g})$, Fe is +3, O is -2

$$2(+3) + 3(-2) = 0$$

④

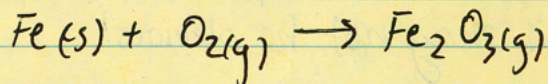
Try it: i) $\text{Cr}_2\text{O}_7^{2-}$

ii) NO_3^-

Cr is +6 since
 $2(+6) + 2(-7) = -2$

N is +5 since
 $+5 + 3(-2) = -1$

So let's ~~revisit~~ examine the following reaction:



The initial oxidation states are:

Fe : 0 } from before.
O : 0 }

Now, the product, Fe has +3 and Oxygen is -2.

So Fe lost electrons and Oxygen gained electrons. Motivates:

Def: During the course of a chemical reaction, if a compound or species loses electrons, we say it has been oxidized. If it gains electrons that it is said to be reduced.

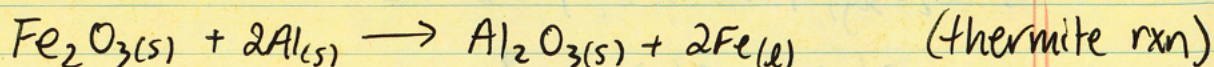
So Fe was oxidized & O was reduced, during the course of the reaction.

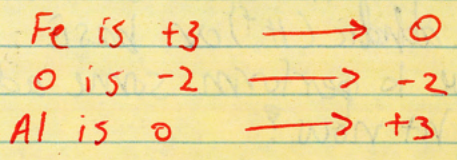
Can use OIL RIG or LEO the lion says GER to remember.

Def: The compound or species that accepts electrons is called the oxidizing agent (causes other species to be ~~red~~ oxidized). Similarly, if it donates electrons, it is called the reducing agent (causes other species to be reduced).

So Fe oxidized but reducing agent.
And O reduced but oxidizing agent.

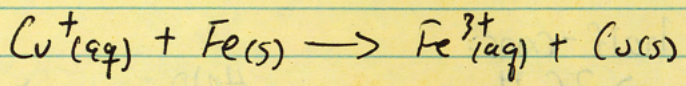
Okay, let's try it: identify the oxidation states of all elements and determine the oxidizing & reducing agent.





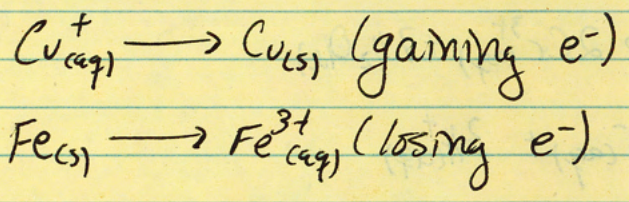
So Fe gained $e^- \Rightarrow$ reduced \therefore thus oxidizing agent
 Al lost $e^- \Rightarrow$ oxidized \therefore thus reducing agent

Now how can we balance redox reactions? From the beginning we had

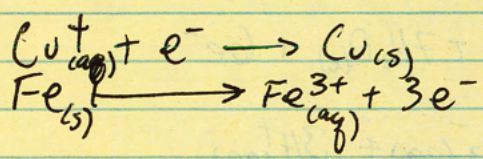


This isn't balanced because the left has a $+1$ overall charge and the right has a $+3$ overall charge. We must have charges be equal (cannot create nor destroy charge!)

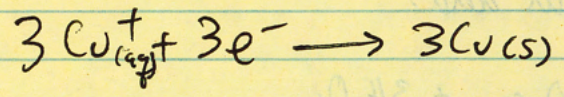
Well, we have



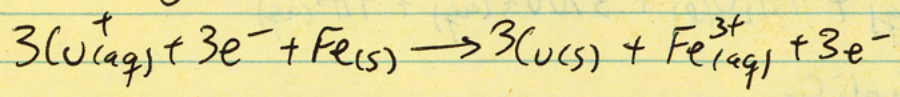
We can write these half-reactions:



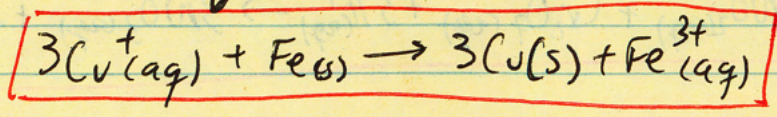
Want total charge conservation, so multiply Cu by 3 to get



Then adding the half-reactions:



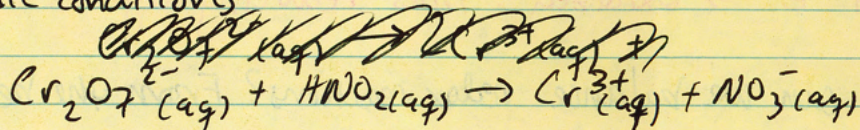
The e^- cancel leaving:



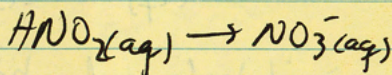
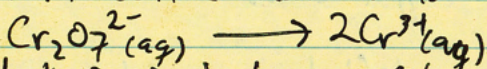
⑥

What we just experienced was balancing half-reactions in a neutral solution. If we were in an acidic (H^+) or basic environment (OH^-), we would have to perform some additional steps. Don't worry about this right now?

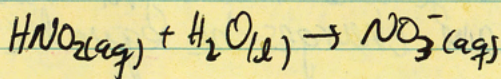
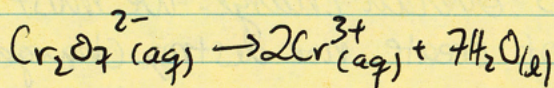
Ex: In acidic conditions



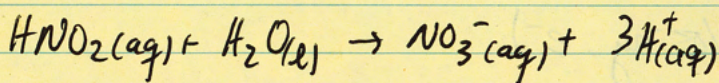
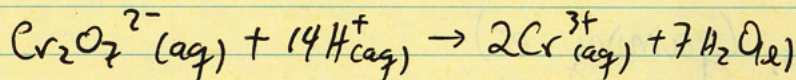
Start with half-rxns:



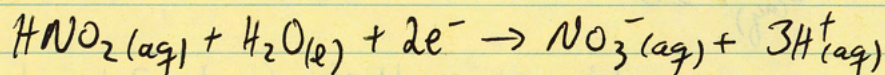
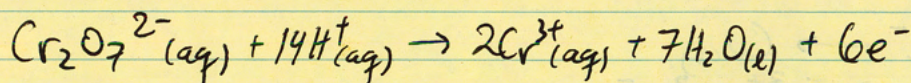
1) Add H_2O to balance O's.



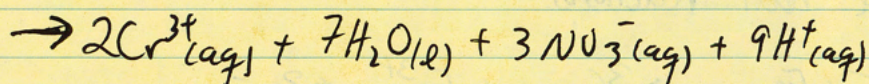
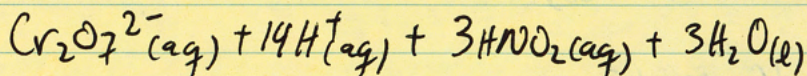
2) Balance H's via H^+ (acidic environment).



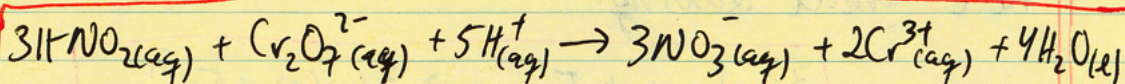
3) Balance charges using e^- :



4) Multiply so e^- cancel and add:

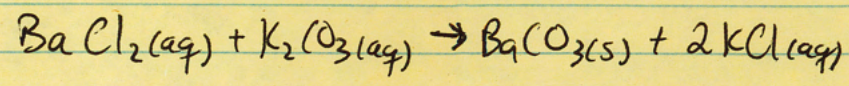


5) Cancel / simplify



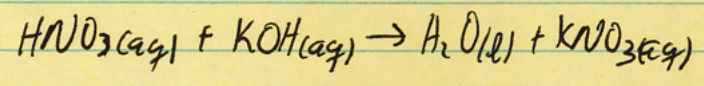
So what we have talked about so far are redox reactions, but we can classify other types of reactions

i) Precipitation

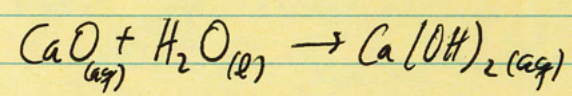


The BaCO_3 is insoluble in water & falls out of solution. Easy to identify precipitation type reactions since they will form a solid from liquid or aqueous reagents.

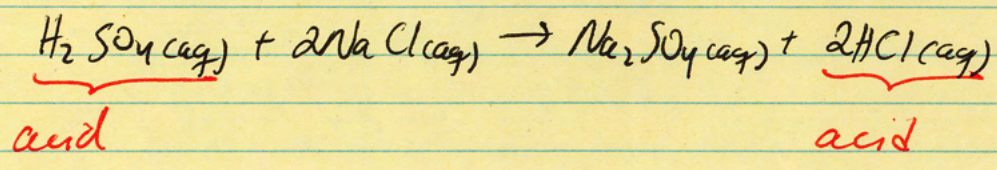
ii) Acid-Base



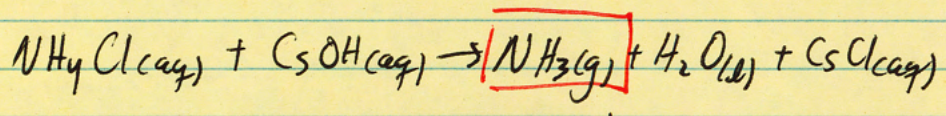
Usually identified by formation of water + salt. What is given above is a neutralization type reaction. Also have hydration of acid/base anhydrides to form acid/bases



and acid/base displacement:



iii) Gas Evolution (Not Part of lab)



Formation of gas (hence the name).