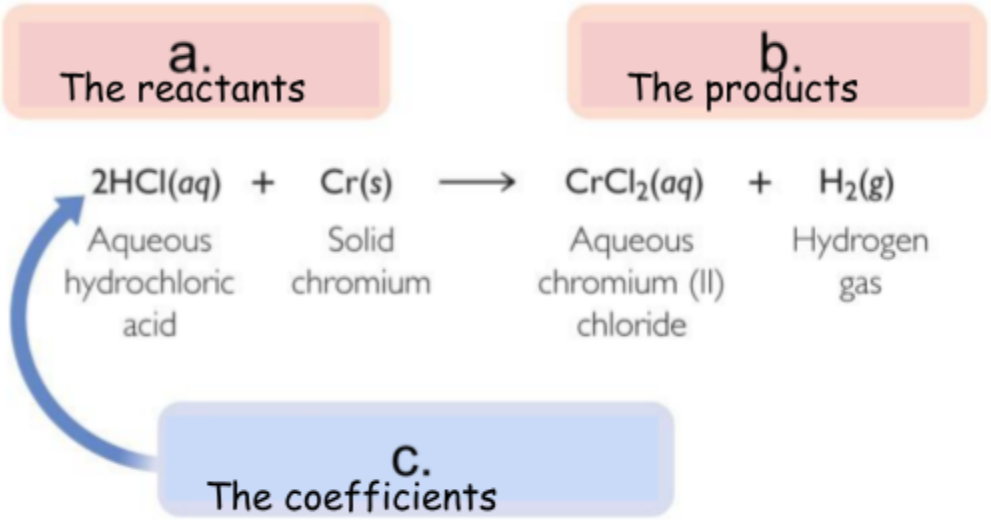
Dacey Duong 8Ga

Unit 6- Chemical Reactions

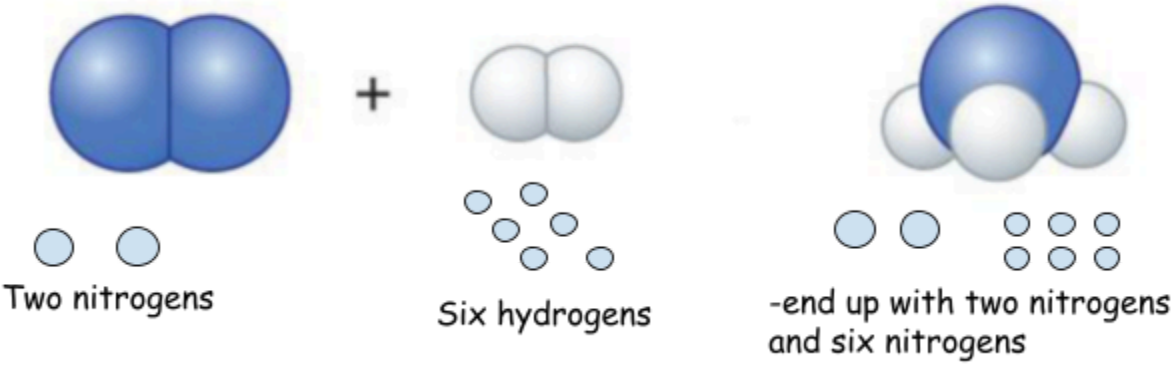
Unit 6 Review part 1

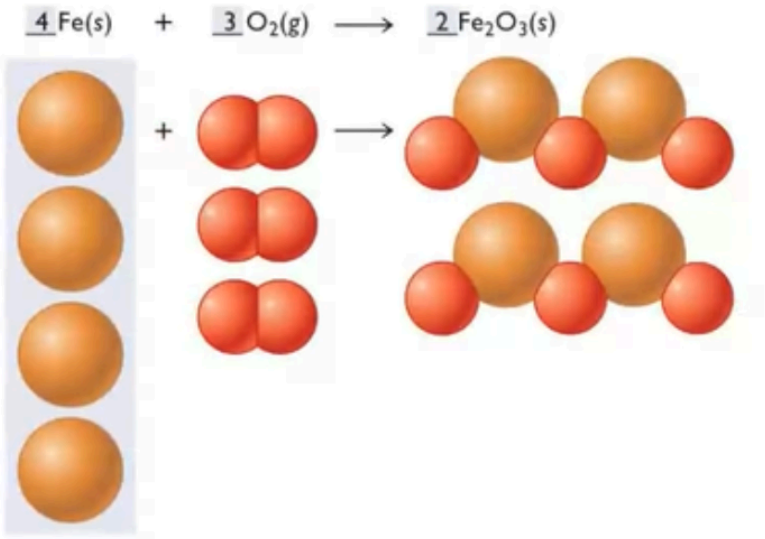


2. How do you balance a reaction?

canNOT change the subscripts of a compound

__ $N_2(g)$ + 3 $H_2(g)$ ⟶ 2 $NH_3(g)$





Ex. **4**Fe(s) + **3**O_2 → **2**Fe_2O_3(s)

-> iron oxide

Unit 6 Review part 2

1. Reaction Types

- Synthesis (Composition/Combination rxn) **A + B → C**
- Decomposition rxn **C → A + B**
- Single-Displacement/Single exchange rxn **A + BC → B + AC**
- Double-Displacement/Double exchange rxn **AB + CD → AD + CB**
- Combustion rxn $C_xH_yO_z + O_2 \rightarrow CO_2 + H_2O$ or $Me + O_2 \rightarrow MeO$

Synthesis Reactions

-multiple reactant but a single product

Desynthesis Reactions

-one single reactant but multiple products

Single Displacement Reactions

-another compound and element is exchanged with another compound and element

Double Displacement Reactions

-a compound and another compound

https://www.youtube.com/watch?v=MYmrWHzT1oI

2. Finish the following syntheses:

$8\ Fe^{2+}(s) + S_8^{2-}(s) \rightarrow 8FeS$

$H_2^{1+}(g) + SO_3^{2-}(g) \rightarrow H_2SO_3$

$CO_2(g) + Na_2O(s) \rightarrow Na_2CO_3$

$CO_2(g) + NaOH(aq) \rightarrow NaHCO_3$ (sodium hydrogen carbonate)

First the get metal in the compound

Ionic compound

Find out a compound that has one hydrogen, three oxygens, and one carbon

Finding the products of a synthesis reaction

-creating one chemical formula **(element + element → compound)**

-find the charge of each ion in the equation

Zn (2+) + O_2 (2-) → $Zn^{(2+)}O^{(2-)}$ (zinc oxide)

-End up with Zn + O_2 → ZnO

-need to balance the equation

- **2**Zn + O_2 → **2**ZnO

-creating one chemical formula **(element + compound → compound)**

-find the **metal** in the ionic compound in equation

-find the other nonmetals in the equation and see what familiar compound it makes

$CaO + CO_2 \rightarrow$????

-combine the metal and combine it with the familiar compound

$CaO + CO_2 \rightarrow CaCO_3$

-balance the equation if needed

-creating one chemical formula **(element + compound → compound)**

-find the **metal** in the ionic compound in equation

-find the other nonmetals in the equation and see what familiar compound it makes

$CaO + CO_2 \rightarrow$????

-combine the metal and combine it with the familiar compound

$CaO + CO_2 \rightarrow CaCO_3$

-balance the equation if needed

Finding the products of decomposition reactions (combustion decomposition reactions)

-if heat is added to break down the substance -> combustion decomposition reaction

-start off with a solid and breaks down into a solid and CO_2

$CaCO_3\ (s) \xrightarrow{heat}$??? + CO_2

Already know that the combustion reaction has a CO_2 in the product

$$CaCO_3\ (s) \xrightarrow{heat} CaO\ (s) + CO_2\ (g)$$

-balance the equation if needed

Finding the products of a decomposition reaction (decomposition reaction with hydroxide)

-if heat is added to break down the substance -> combustion decomposition reaction

-starts off with a solid and the hydroxide evaporates into water (gas)

-> end up with H_2O in the product (water vapor NOT liquid water)

$$Ca(OH)_2\ (s) \rightarrow ???? + H_2O\ (g)$$

-already know that the equation has water vapor($H_2O_{(gas)}$) in the products of the equation, because it is a decomposition combustion reaction with hydroxide

$$Ca(OH)_2\ (s) \rightarrow CaO\ (s) + H_2O\ (g)$$

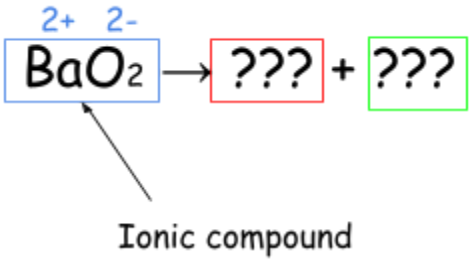
-balance the equation if needed

Finding the products of a decomposition reaction

-creating one chemical formula **(compound → compound/element + element)**

-find the **metal** in the ionic compound in equation

-find the other nonmetals in the equation and see what familiar compound it makes



-find the charge of every atom

One compound in the products side will be an ionic compound with one metal and nonmetal (so it will have **Ba and O**)

-oxygen usually comes in O2 not just O

There will be one element in the products side (since there is only one barium and it is with the ionic compound in the products side it will be **oxygen which will be alone on the products side**)

$$BaO_2 \rightarrow BaO + O_2$$

-balance the equation if needed

-> $2BaO_2 \rightarrow 2BaO + O_2$

3. Finish the following decomposition reactions:

$CaCO_3(s) \rightarrow CaO\ (s) + CO_2\ (g)$

$Ca(OH)_2(s) \rightarrow CaO\ (s) + H_2O\ (g)$

$2KClO_3(s) \rightarrow 2KCl\ (s) + 3O_2\ (g)$

$BaO_2(s) \rightarrow 2BaO\ (s) + O_2\ (g)$

$2H_2O(l) \rightarrow 2H_2\ (g) + O_2\ (g)$

Finding the products of a single displacement reaction

-find the charge of each element in the compound

-always in a single replacement reaction there will be a ionic compound (metal and nonmetal) -most of the time

-mix them up

$Zn\ (s) + CuSO_4 \rightarrow Cu + ZnSO_4$

-ionic compound

4. Finish the following single exchange rxns:

$Zn(s) + CuSO_4(aq) \rightarrow Cu(s) + ZnSO_4(aq)$

$Ca(s) + 2H_2O(l) \rightarrow Ca(OH)_2(aq) + H_2(g)$

$Zn(s) + H_2SO_4(aq) \rightarrow H_2(g) + ZnSO_4(aq)$

$Cl_2(g) + 2KBr(s) \rightarrow Br_2(l) + 2KCl(s)$

-if there is H_2O in one side of the equation -> there is hydroxide on the other side of the equation

5. Finish the following double exchange reactions:

$$FeS(s) + 2HCl(aq) \rightarrow FeCl_2(aq) + H_2S(g)$$

Gas formation

$$NaCl(aq) + AgNO_3(aq) \rightarrow AgCl(s) + NaNO_3(aq)$$

Precipitation Reaction

$$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$$

6.1 - Acid Based Reactions

6.1.1 - Neutralization Reactions

What is an acid?

An acid is a compound **that readily donates H + ions** in solution (HNO_3, H_3PO_4, H_2SO_4)

1a) Write a chemical equation showing that H_2SO_4 is an acid.

$$H_2SO_{4(aq)} \rightarrow H^+_{(aq)} + HSO_4^-{}_{(aq)} \rightarrow H^+ + SO_4^{2-}$$

What is a base?

A base is a compound **that readily donates OH - ions** in solution (Na**OH**, Ca(**OH**)$_2$, NH_4**OH**)

-could be a compound that accepts protons

2a) Write a chemical equation showing that NaOH is a base.

$NaOH_{(aq)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$ Arrhenius base

$OH^-_{(aq)} + H^+_{(aq)} \rightarrow H_2O_{(l)}$ Brønsted-Lowry base

Water is a special

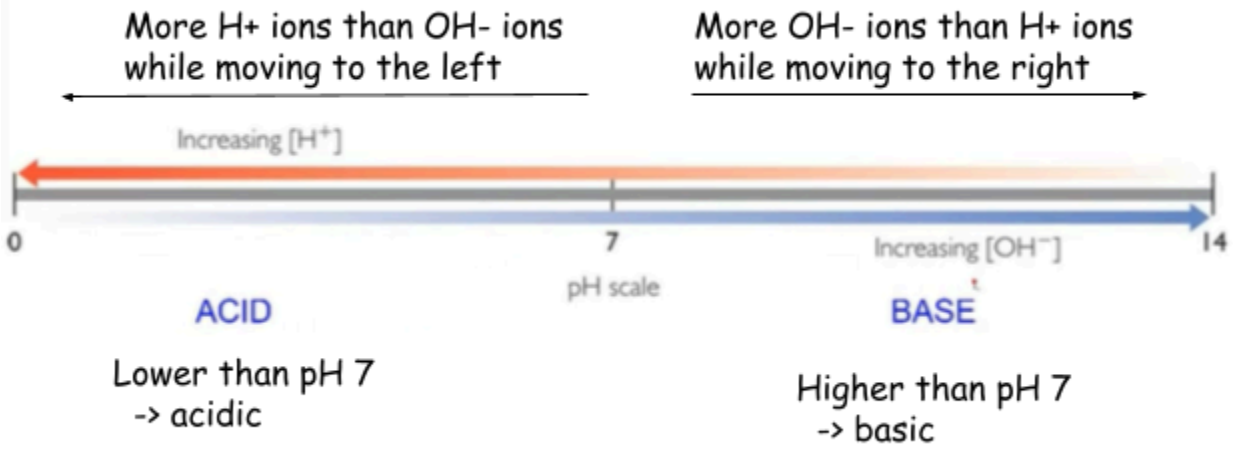
-can act both as an acid and a base (amphoteric)

$H_2O \rightarrow H^+_{(aq)} + OH^-_{(aq)}$ acid (donating H^+) and base (donating OH^-)

OR

$H_2O + H^+_{(aq)} \rightarrow H_3O^+_{(aq)}$ base (accepting a H^+ ion)

4. Acids and bases are measured on the pH scale. Where are the acids and the bases on the scale?



Predicting products of acid based reactions (neutralization reactions)

Neutralization reaction: Acid + Base → water + Aqueous solution

-neutralization reaction is one type of acid based reaction that has a solid in the products

$$HCl\,(aq) + NaOH(aq) \rightarrow NaCl_{(aq)} + H_2O_{(l)}$$

acid base

-base (NaOH) creates water, because of the OH- ion

-neutralization reactions always have an acid and base

-> bases always have an OH

-> the product will always have water

-use the two elements or compounds that are not O and H

-> use them to form the aqueous solution

-balance if needed

6. Neutralization reactions produce a salt and water. Predict products for the following reactions:

$HCl(aq) + KOH(aq) \longrightarrow$ KCl (aq) + H_2O (l)

$HNO_3(aq) + NaOH(aq) \longrightarrow$ $NaNO_3$ (aq) + H_2O (l)

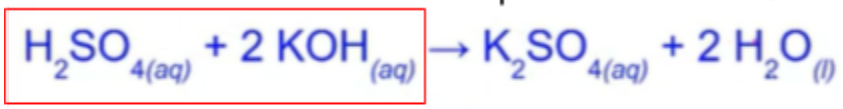
$H_2SO_4(aq) + 2NaOH(aq) \longrightarrow$ $NaSO_4$ (aq) + $2H_2O$ (l)

$2HCl + Mg(OH)_2(aq) \longrightarrow$ $MgCl_2$ (aq) + $2H_2O$ (l)

$H_2SO_4(aq) + Ca(OH)_2(aq) \longrightarrow$ $CaSO_4$ (aq) + $2H_2O$ (l)

7. **Using the acids and bases in this table, how would you make potassium sulfate? Write a balanced equation.**

-finding the two compounds that have potassium and sulfate



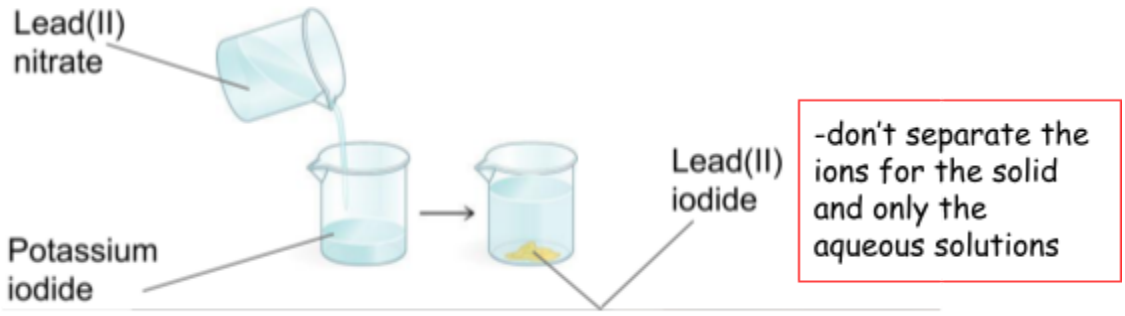
Acids	Bases
HNO_3	KOH
H_2SO_4	NaOH
HBr	$Mg(OH)_2$

8. **Milk of Magnesia (magnesium hydroxide suspension in water) is used to neutralize stomach acid. Write a balanced equation:**

6.2a- Precipitation Reactions

1. Write a balanced chemical equation for the following precipitation reaction:

$$Pb(NO_3)_2\,(aq) + 2KI\,(aq) \rightarrow PbI_2\,(s) + 2KNO_3\,(aq)$$



Converting the chemical equation to an ionic equation
(separate the elements and polyatomic ions into ions with their charge)

$$Pb^{2+}(aq) + 2NO_3^-(aq) + 2K^+(aq) + 2I^-(aq) \rightarrow \boxed{PbI_2}\,(s) + 2K^+(aq) + 2NO_3^-(aq)$$

-don't touch the solid

Which property of ionic compounds determines whether or not a precipitate forms??

-solubility

-use the solubility rules to figure out which compound is the solid (insoluble) and which one is the aqueous solution (soluble) in the products of the precipitation reaction

4. Solubility rules:

- ☑ Most nitrate salts are soluble
- ☑ Most salts of alkali metals and ammonium are soluble
- ☐ Most halide salts are soluble
  - Exceptions: Silver, Lead (II), Mercury (I)
- ☐ Most sulfate salts are soluble
  - Exceptions: Barium, Lead (II), Mercury (I), Calcium
- ☐ Most hydroxides are slightly soluble (effectively insoluble)
  - Exceptions: Potassium, Sodium
- ☐ Most sulfide, carbonate, chromate, and phosphate salts are slightly soluble

5. Upon combining aqueous calcium nitrate with aqueous sodium phosphate, do you expect a precipitate?

$Ca(NO_3)_2$ (aq) + Na_3PO_4 (aq) → ???? (s) + ??? (aq)

-find the products like in a double replacement reaction
-find out if the compounds in the products are soluble or not soluble
  -if soluble -> aqueous solution
  -if not soluble (insoluble) -> forms a solid

$3Ca(NO_3)_2$ (aq) + $2Na_3PO_4$ (aq) → $Ca_3(PO_4)_2$ (s) + $6NaNO_3$ (aq)

-forms a solid and a aqueous solution -> yes it is a precipitation reaction

6. Write the same reaction in a complete ionic equation.

$$3Ca^{2+}_{(aq)} + 6NO^{-}_{3\,(aq)} + 6Na^{+}_{(aq)} + 2PO^{3-}_{4\,(aq)} \rightarrow Ca_3(PO_4)_{2(s)} + 6Na^{+}_{(aq)} + 6NO^{-}_{3\,(aq)}$$

The Na and NO_3 are found on both sides of the reactant in exactly the same way and are called **spectator ions**. Since they are in both sides of the equation, you can cancel them out.

6. Write the same reaction in a complete ionic equation.

-cross all the spectator ions out

$3Ca^{2+}_{(aq)} + 6NO_{3\,(aq)}^{-} + 6Na^{+}_{(aq)} + 2PO_{4\,(aq)}^{3-} \rightarrow Ca_3(PO_4)_{2(s)} +$

$6Na^{+}_{(aq)} + 6NO_{3\,(aq)}^{-}$

-end up with...

-end up with the solid
-is an easy way to find the solid in a precipitation reaction

$3Ca^{2+}_{(aq)} + 2PO_{4\,(aq)}^{3-} \rightarrow Ca_3(PO_4)_{2(s)}$

How to find the products in a precipitation reaction

-predict the products like in a double displacement reaction (exchanging each of the elements and making sure that they make a zero charge compound)

-use solubility rules to figure out if the compound is soluble or not

-not soluble -> form solid

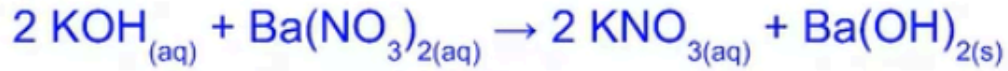
-soluble -> form aqueous solution

10. Practice:

- Identify the following as soluble - S or insoluble - I
  - S KCl
  - S $AgNO_3$
  - I $AgCl$
  - S KNO_3
  - S K_2CrO_4
  - S $Ba(NO_3)_2$
  - I $BaCrO_4$
  - S Na_2SO_4
  - S $Pb(NO_3)_2$
  - I $PbSO_4$
  - S $NaNO_3$
  - S KOH
  - S $Fe(NO_3)_3$
  - I $Fe(OH)_3$
  - S H_2SO_4 but not ionic...
  - S $K_2Cr_2O_7$
  - S $Co(NO_3)_2$

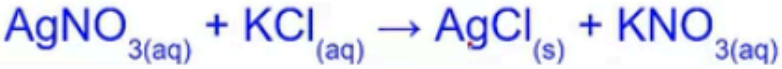
11. Predict the products of, write and balance the following reactions. Identify any precipitates. All reactants are aqueous.

1. Potassium hydroxide reacts with barium nitrate



$$2\,KOH_{(aq)} + Ba(NO_3)_{2(aq)} \rightarrow 2\,KNO_{3(aq)} + Ba(OH)_{2(s)}$$

2. Silver nitrate reacts with potassium chloride



$$AgNO_{3(aq)} + KCl_{(aq)} \rightarrow AgCl_{(s)} + KNO_{3(aq)}$$

6.2b - Combustion Reactions

1. Which of the following compounds combusts?

- $NaCl\,(s)$ Doesn't combust
- $Fe_2O_3(s)$ Doesn't combust
- $Ni(s)$ Can combust
- $Mg(s)$ Can combust
- $H_2O(l)$ Doesn't combust (but is a product of a combustion reaction)
- $CH_3(CH_2)_6CH_3(l)$ Can combust (is a hydrocarbon which is a compound with carbon and hydrogen and can combust easily) <- found in gasoline
- $CO_2(g)$ Doesn't combust (is a product of a combustion reaction
- $H_2(g)$ Can combust (H2 is very flammable)
- $SiO_2(s)$ Doesn't combust
- $C_6H_{12}O_6(s)$ (paper) Can combust (is pretty much sugar and we burn sugar in our bodies to create energy)

How do we figure out which compound can be combustible or not??

-ionic compounds cannot combust (like NaCl, kitchen salt cannot combust)

-molecular covalent compounds CAN COMBUST

-ESPECIALLY hydrocarbons (which are found in gasoline)

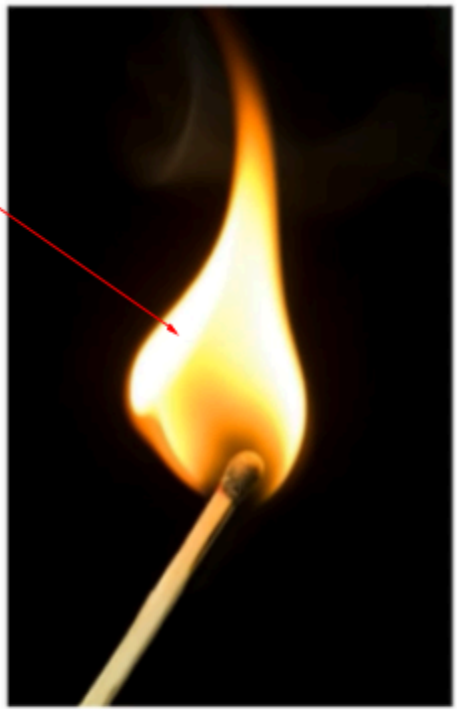
-elemental metals (or any elemental atoms) can combust (things like H_2, Ni, O_2, etc.)

-water and carbon dioxide cannot combust, because they are the products of a combustion reaction and cannot combust any further

3a. What is a flame?

-body of heated gases (the electrons get excited)

-as the electrons fall back to their original state (they give off light)



3b. Do all combustion reactions produce a flame?

-No, not all combustion reactions produce a flame (such as combusting metals)

-get bright light but no flame (no flame, because the products are not gases)

6.3- Chemical Reaction Types

-redox reactions stand for **reduction and oxidation reactions**.

2. Write down a possible chemical rxn for winning elemental iron out of ore (iron rust) and balance it.

$2Fe_2O_3\ (s) \rightarrow 4Fe\ (s) + 3O_2\ (g)$

Electrons flow from the negative ion to the positive ion. The iron had a charge of 3+ and oxygen had a charge of 2-. The both elements combine to become neutral charge.

4. Write down an equation for each element and its electrons.

For positive charged ions
-> add electrons on <u>the reactants side</u> to make it a neutral charge on the products side
For negative charged ions
-> add electrons on <u>the products side</u> to make it balanced on both sides

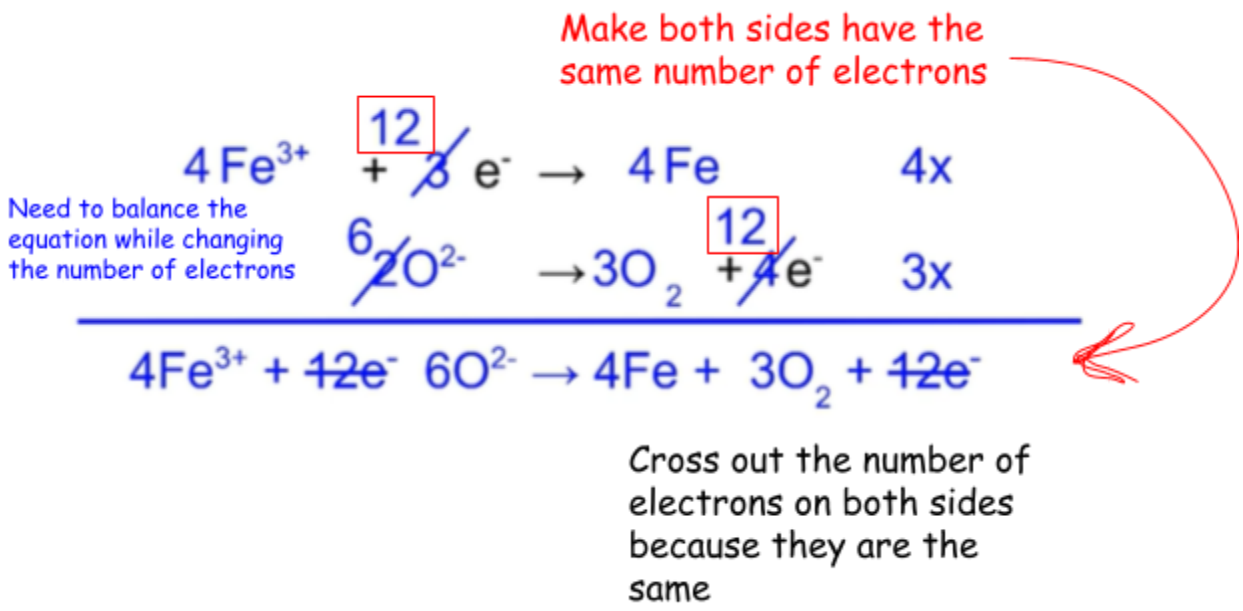
$Fe^{3+} + 3e^- \rightarrow Fe$

$O^{2-} \rightarrow O_2 + 4e^-$

-oxygen always comes in the form of O2 so you double the number of electrons

Iron has a 3+ charge and when we add three, minus one charges by adding 3 electrons
-> becomes neutral

Oxygen has a 2- charge so to make it balanced on both sides; you add 2 minus one charges by adding two electrons on the products side.

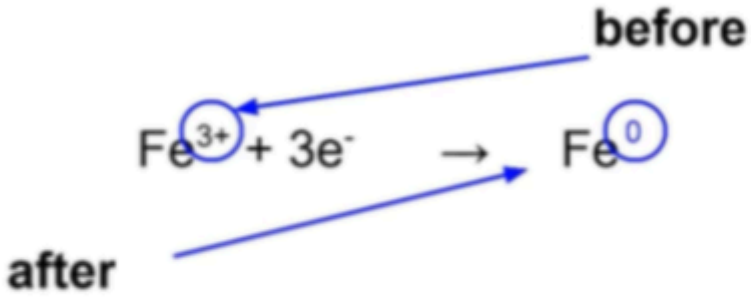


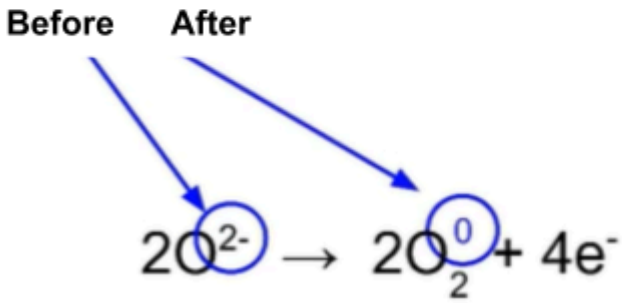
-end up with:

$$2Fe_2O_3(s) \longrightarrow 4Fe(s) + 3O_2(g)$$

-before the oxidation state for iron is 3+
-after the oxidation state for iron is 0

Oxidation state = charge





Remember OIL RIG

Oxidation **I**s **L**osing electrons

-the oxygen atoms are being oxidized and losing their electrons

Reduction **I**s **G**aining electrons

-metals are usually the one being reduced (iron oxide is being broken down into its element state)

-> iron is being reduced

-do the stuff processes above to figure out what is reduced and oxidized

8. For the following redox rxn, write down the 2 half-rxns showing oxidation and reduction of each element:

$$2Zn(s) + O_2(g) \rightarrow 2ZnO(s)$$

$$Zn \rightarrow Zn^{2+} + 2e^-$$

Zinc loses electrons (oxidation)

$$O_2 + 4e^- \rightarrow 2O^{2-}$$

Oxygen gains electrons (reduction)

Oxidation cannot take place with a reduction. Same other way around.

-> thats why its called reduction oxidation reaction (redox reaction)

11. What is an oxidizing agent?

The oxidizing agent is the element that causes the of oxidation other elements but is reduced itself

What is a reducing agent?

The reducing agent is the element that causes the reduction of other elements but is oxidized itself

Give examples of each.

In the $FeCl_2$ example
Iron is the reducing agent
Chlorine (Cl_2) is the oxidizing agent
Oxygen is the reducing agent

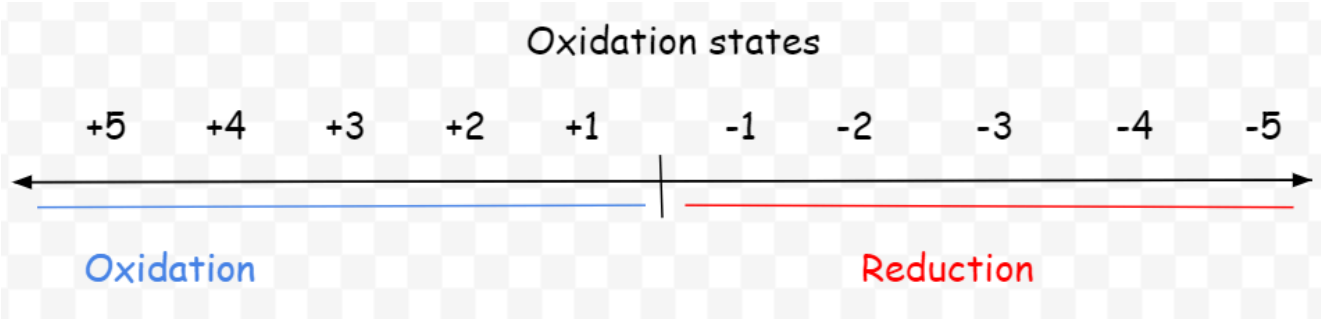
-double replacement reactions are never redox

-precipitation reactions are never redox

-Combustion reactions are redox

How do you know which one is the reducing and oxidizing agent?

-finding the oxidation states https://www.youtube.com/watch?v=iSAwDJTLIKY



-oxidation states change in reactions

Oxidation- losing electrons, gaining an oxygen, moving up in oxidation state

Reduction- gaining electrons, losing an oxygen, gaining a hydrogen atom, or moving down in oxidation state