42.081 g/mol

$$4\,C_3H_6 + 6\,NO \longrightarrow 4\,C_3H_3N + 6\,H_2O + N_2$$

propylene

53.064 g/mol

acrylonitrile

Calculate how many grams of acrylonitrile could be obtained from 651 kg of propylene, assuming there is excess NO present. (651000 g)

1 - Change the mass of propylene to moles propylene (formula weight of propylene)
2- Change moles propylene to moles acrylonitrile (use ratio from chemical equation)
3 - Change moles acrylonitrile to grams (formula weight of acrylonitrile)

42.081 g prop = 1 mol prop | 4 mol prop = 4 mol acn | 53.064 g acn = 1 mol acn

$$651000\ \text{g prop} \times \frac{1\ \text{mol prop}}{42.081\ \text{g prop}} \times \frac{4\ \text{mol acn}}{4\ \text{mol prop}} \times \frac{53.064\ \text{g acn}}{1\ \text{mol acn}} = \boxed{821000\ \text{g acn}}$$

(1) (2) (3)

(821 kg)

$$10\,FeSO_4 + 2\,KMnO_4 + 8\,H_2SO_4 \rightarrow 5\,Fe_2(SO_4)_3 + 2\,MnSO_4 + K_2SO_4 + 8\,H_2O$$

How many mL of 0.250M potassium permangenate are needed to react with 3.36 g of iron(II) sulfate?

1- Change grams iron(II) sulfate to moles iron(II) sulfate (formula weight of iron(II) sulfate)
2- Change moles iron(II) sulfate to moles potassium permangenate (ratio from chemical eqn)
3- Change moles potassium permangenate to volume (molar concentration of solution)

151.90 g $FeSO_4$ = 1 mol $FeSO_4$ | 10 mol $FeSO_4$ = 2 mol $KMnO_4$ |

0.250 M : 0.250 mol $KMnO_4$ = 1 L

$$3.36\,g\,FeSO_4 \times \frac{1\,mol\,FeSO_4}{151.90\,g\,FeSO_4} \times \frac{2\,mol\,KMnO_4}{10\,mol\,FeSO_4} \times \frac{1\,L}{0.250\,mol\,KMnO_4} = 0.0177\,L\ solution$$

$mL = 10^{-3}\,L$

$$0.0177\,L \times \frac{mL}{10^{-3}\,L} = 17.7\,mL\ of\ 0.250M\ KMnO_4$$

Electrolytes and Ionic Theory

- electrolytes: substances that dissolve in water to form charge-carrying solutions

* Electrolytes form ions in solution - (ions that are mobile are able to carry charge!). These IONS can undergo certain kinds of chemistry!

IONIC THEORY

- the idea that certain compounds DISSOCIATE in water to form free IONS

What kind of compounds?

- Soluble ionic compounds
- Acids (strong AND weak)
- Bases (strong AND weak)

The ions formed may interact with each other to form NEW compounds!

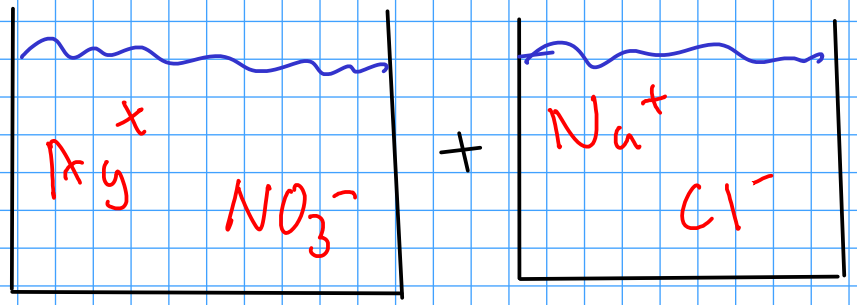
Strong vs weak?

- If an electrolyte COMPLETELY IONIZES in water, it's said to be STRONG
- If an electrolyte only PARTIALLY IONIZES in water, it's said to be WEAK
- Both kinds of electrolyte undergo similar kinds of chemistry.

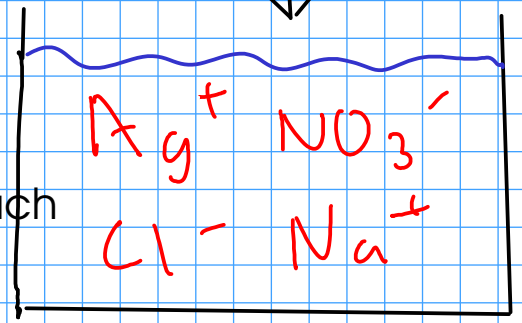
- provides an easy-to-understand MECHANISM for certain kinds of chemical reactions.

- "Exchange" reactions. (a.k.a "double replacement" reactions)

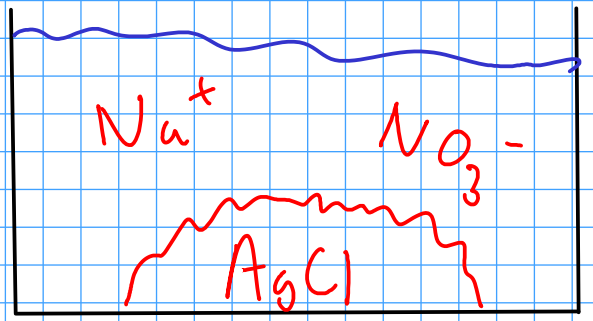
$$AgNO_3(aq) + NaCl(aq) \longrightarrow AgCl(s) + NaNO_3(aq)$$



These free ions mix and can interact with each other!

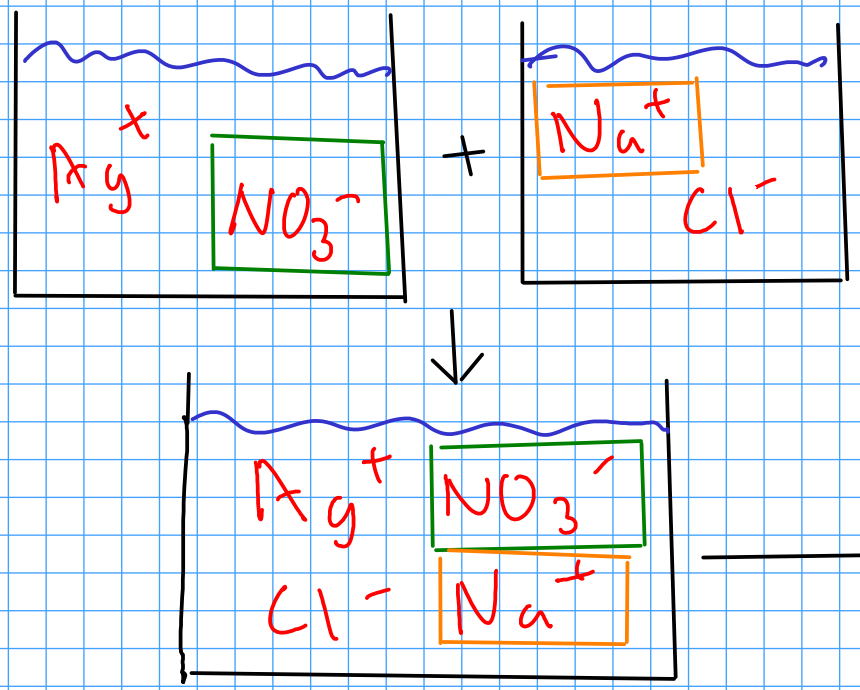


"ion soup"!



Insoluble AgCl falls out of solution as it is formed - "precipitation"

Looking a bit more closely...



The nitrate and sodium ions do not really participate in this reaction. They start and end in exactly the same state. We cal them "SPECTATOR IONS".

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

$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$$ "Net ionic equation"

(The net ionic equation shows only ions and substances that change during the course of the reaction!)

- The net ionic equation tells us that any source of aqueous silver and chloride ions will exhibit this same chemistry, not just silver nitrate and sodium chloride!

A bit more about molecular, ionic, and net ionic equations

- molecular equations: Represent all substances (even ionic substances) as if they were molecules. Include spectator ions, and do not show charges on ions. Traditional chemical equations.

- ionic equations: Show all free ions - including spectators - in a chemical reaction. Molecules and WEAK electrolytes are shown as molecules. STRONG electrolytes (like HCl) are shown as ions. Ions that are part of undissolved ionic compounds are shown as molecules.

- NET ionic equation: An ionic equation that leaves out spectator ions. Intended to show only things that actually change in a reaction.

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

$$Ag^+(aq) + NO_3^-(aq) + Na^+(aq) + Cl^-(aq) \rightarrow AgCl(s) + Na^+(aq) + NO_3^-(aq)$$ *

$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$$

* You can get from the complete ionic equation to the net ionic equation by crossing out the spectator ions on both sides.

"Undissolved ionic compounds":

How can I tell if an ionic compound dissolves in water?

- consult experimental data: "solubility rules", or use the course web site!

A few of the "rules"...

- Compounds that contain a Group IA cation (or ammonium) are soluble
- Nitrates and acetates are soluble
- Carbonates phosphates, and hydroxides tend to be insoluble

See p 129 9th edition

Exchange Chemistry

- Three kinds of exchange chemistry.

1. PRECIPITATION
2. ACID/BASE or NEUTRALIZATION
3. GAS FORMATION (formation of unstable molecules)

↑ sump gas - formers

- Just because you mix together two ionic compounds does NOT mean that a reaction will occur. You need a DRIVING FORCE for a reaction.

PRECIPITATION

- driving force is the formation of an insoluble ionic compound.

insoluble! precipitates

$3MgCl_2(aq) + 2Na_3PO_4(aq) \rightarrow 6NaCl(aq) + Mg_3(PO_4)_2(s)$

ions: Mg^{2+} Cl^- Na^+ PO_4^{3-}

Potential Products:

$NaCl$

$Mg_3(PO_4)_2$

When you're trying to complete a precipitation reaction:

1. Write the IONS that form when the reactants are dissolved.
2. Make NEW compounds by pairing up cations with anions. Don't forget that the positive and negative charges must balance each other out!
3. Use the solubility rules to determine the PHASE of each new compound - solid or aqeous.
4. Balance the overall equation.