

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

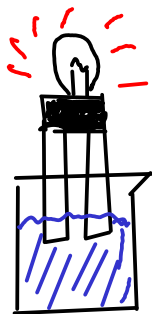
What kind of compounds?

- 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.

Ionic theory experiment

Simple conductivity tester: The stronger the electrolyte, the brighter the light.

SOME PURE COMPOUNDS (MOLECULAR AND IONIC)

DISTILLED WATER

No light. Pure water is a NONCONDUCTOR - it doesn't carry an appreciable electric current.

SOLID SODIUM CHLORIDE

Nonconductor (no light). There ARE charged particles, but they're stuck in NaCl crystals, so they can't carry a charge from prong to prong.

SOLID SUCROSE $C_{12}H_{22}O_{11}$

Like water, this molecular compound is a nonconductor; it's made of neutral molecules.

MOLECULAR AND IONIC SOLUTIONS

SODIUM CHLORIDE + WATER

Bright light. Sodium chloride (like other soluble ionic compounds) is a STRONG ELECTROLYTE. It breaks apart in water to form free ions.

SUCROSE + WATER

No light. The sugar water is a NONELECTROLYTE. Sucrose molecules do not break apart in water to form ions.

ACIDS

PURE (GLACIAL) ACETIC ACID

No light. Like water, this is a molecular substance. In the liquid state, there are no charge carriers (ions) to carry a current. It's a nonconductor.

ACETIC ACID + WATER

Dim light. Acetic acid is a WEAK ELECTROLYTE. SOME molecules of acetic acid break up to form ions, but others do not.

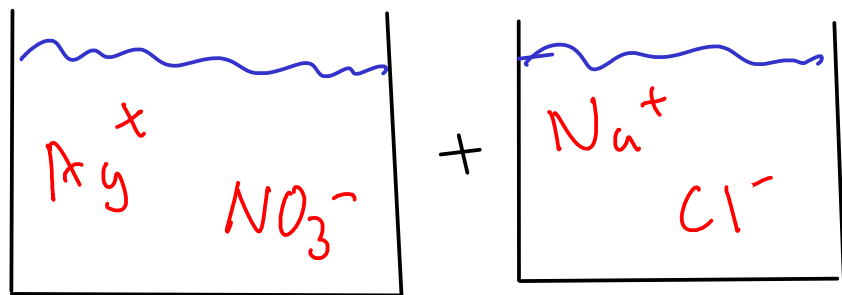
2M ACETIC ACID (AQUEOUS)

Somewhat dim light. WEAK ELECTROLYTE, since the same concentration of HCl gives more light.

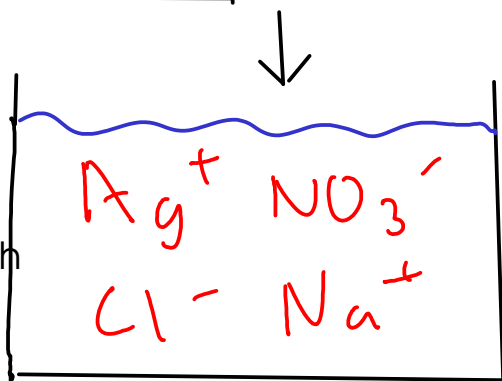
2M HYDROCHLORIC ACID (AQUEOUS)

Bright light. Hydrochloric acid is a STRONG ELECTROLYTE (at least, it's stronger than acetic acid!)

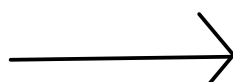
- provides an easy-to-understand MECHANISM for certain kinds of chemical reactions.
 - "Exchange" reactions. (a.k.a "double replacement" reactions)



These free ions mix and can interact with each other!

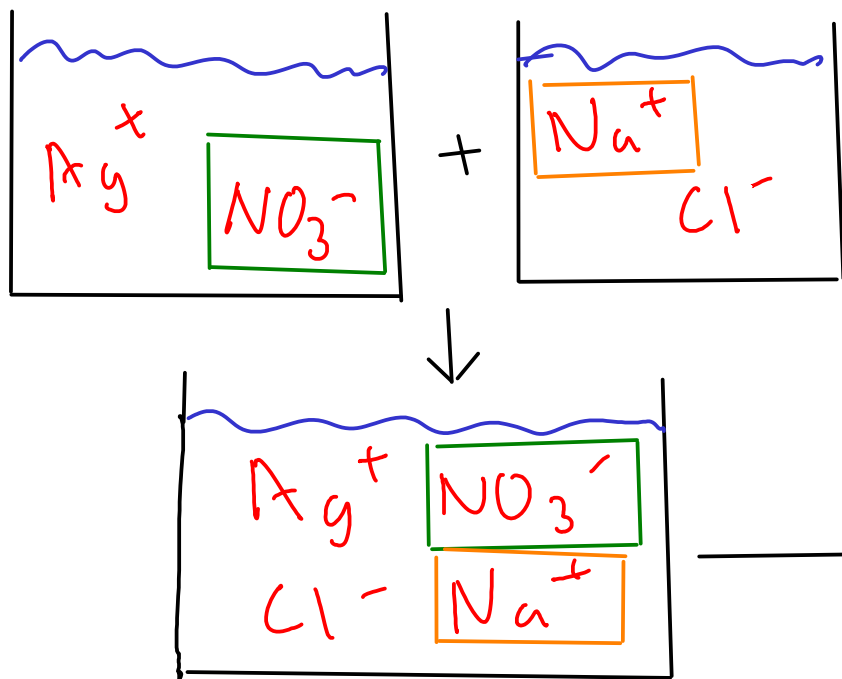


"ion soup"!

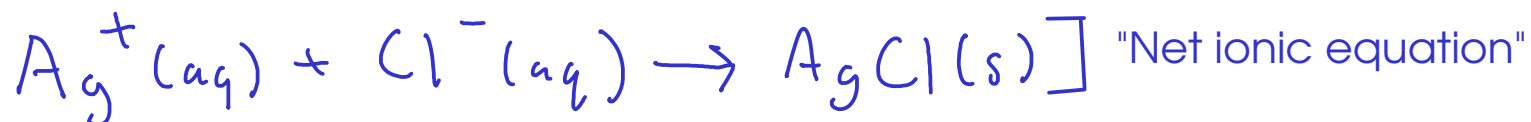


Insoluble AgCl falls out of solution as it is formed - "precipitation"

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 call them "SPECTATOR IONS".



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

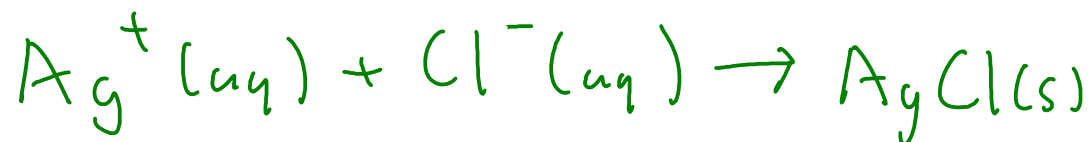
- The net ionic equation tells us that any source of aqueous silver and chloride ions will exhibit this same chemistry, not just silver nitrate and sodium chloride!

115 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.



* 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"!

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

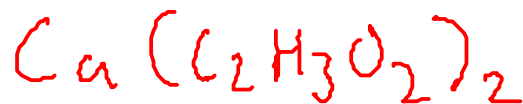
See p 129 9th edition

... or see the web site for a solubility chart.



#8 - hydroxides generally insoluble, except Group IA, ammonium, calcium, strontium, barium

Conclusion: iron(III) hydroxide is insoluble.



#2 - acetates are soluble, no common exceptions.

Conclusion: calcium acetate is soluble.



#3 - Iodides usually dissolve, exceptions are silver, mercury, lead

Conclusion: silver(I) iodide is INSOLUBLE