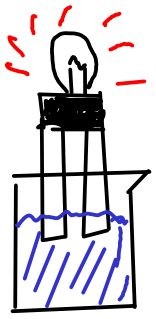
Ionic theory experiment



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. A typical molecule.

SOLID SODIUM CHLORIDE

No light. There are charge carriers in sodium chloride, but they are locked into place in the crystal structure of NaCl

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

Like water, this molecular compound is a nonconductor in the solid state.

MOLECULAR AND IONIC SOLUTIONS

SODIUM CHLORIDE + WATER

bright light: Sodium chloride is a STRONG ELECTROLYTE - it breaks apart in water to form free ions

SUCROSE + WATER

No light. Sucrose (like most molecules) is a NONELECTROLYTE - it does not form a charge-carrying solution in water.

ACIDS

PURE (GLACIAL) ACETIC ACID

No light, Like water, pure acetic acid is a NONCONDUCTOR. In the liqud state, there are no charge carriers - since acetic acid exists as neutral molecules here.

ACETIC ACID + WATER

Dim light. Acetic acid is a WEAK ELECTROLYTE - some molecules (but not all) are pulled apart in water to make ions.

2M ACETIC ACID (AQUEOUS)

Somewhat dim light - so acetic acid is definitely a weak electrolyte. (HCl gave a much brighter light)

2M HYDROCHLORIC ACID (AQUEOUS)

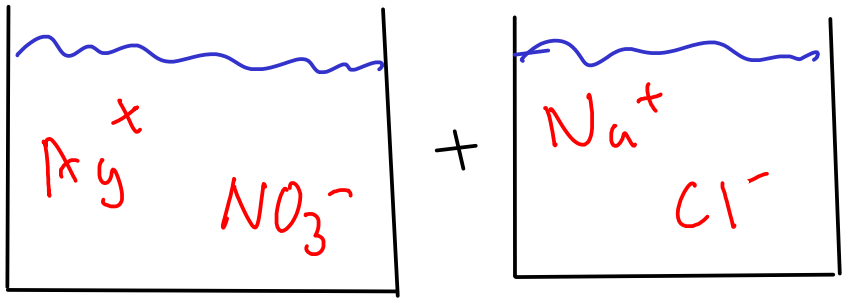
Very bright light. HCl is a STRONG ELECTROLYTE (or at least, stronger than acetic acid!)

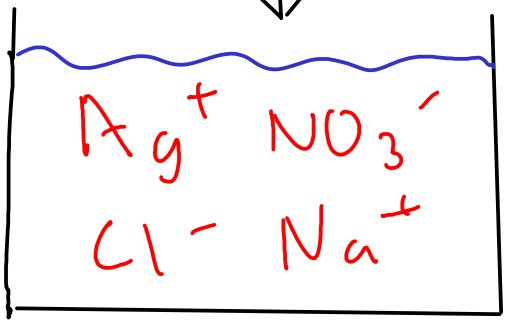
- What good is ionic theory?

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

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

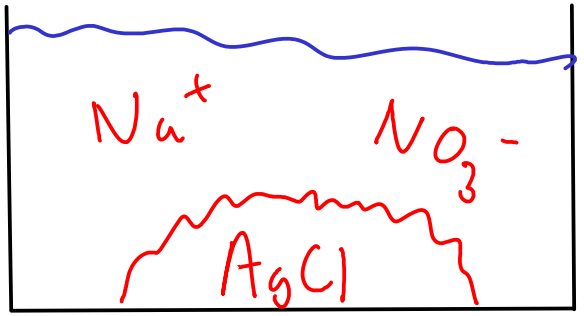
$AgNO_3(aq) + NaCl(aq) \longrightarrow AgCl(s) + NaNO_3(aq)$





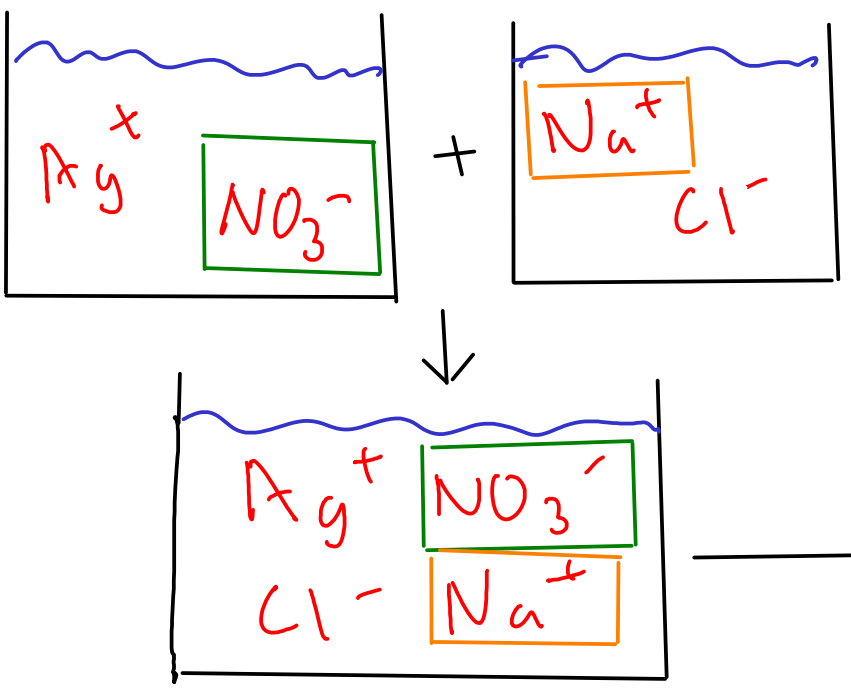
These free ions mix and can interact with each other!

"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 call 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.

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

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

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

* 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"!

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 (p131, 10th)

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

$Fe(OH)_3$

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

Conclusion: iron(III) hydroxide is insoluble.

$Ca(C_2H_3O_2)_2$

#2 - acetates are soluble, no common exceptions.

Conclusion: calcium acetate is soluble.

AgI

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

Conclusion: silver(I) iodide is INSOLUBLE