Announcements

Wednesday, October 07, 2009

MasteringChemistry due dates (all at 11:59pm):

- Ch 4: Wed, Oct 14
- Ch 5: Fri, Oct 23
- Ch 6: Fri, Oct 30

Lab report due dates (all at 3:00pm):

- Exp 5: Wed, Oct 14
- Exp 6: Mon, Oct 19

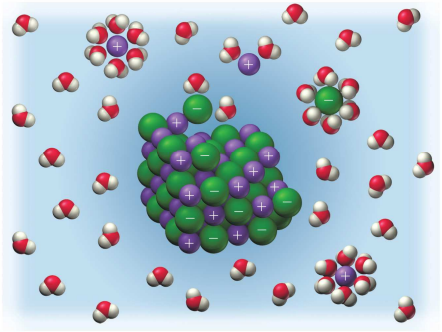
The next round of graded lab reports will be returned to you this week (some on Friday).

Dissolving of electrolytes

Electrolytes **dissociate into ions** when dissolving

$$NaCl(s) \xrightarrow{H_2O} \underbrace{Na^+(aq) + Cl^-(aq)}_{\text{dissolved ions}}$$

Dissolution of an Ionic Compound

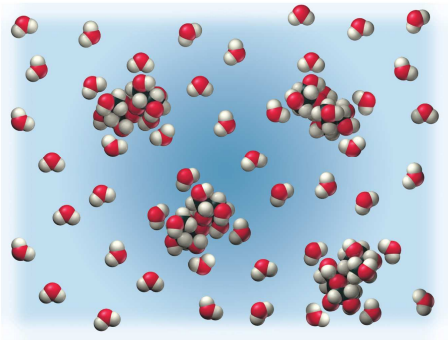


- ions separated
- surrounded by H_2O molecules

ions allow electricity to be conducted

Nonelectrolytes **remain as neutral molecules** when dissolving

Sugar Solution



Acids are molecular substances that dissociate when dissolved to release H^+ ions.

Strong electrolytes dissociate completely into ions:

$NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$

$HCl(g) \rightarrow H^+(aq) + Cl^-(aq)$

Weak electrolytes do not completely dissociate into ions:

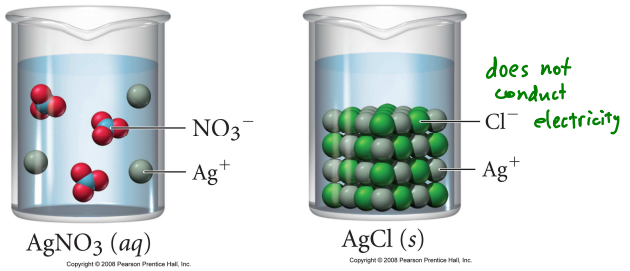
$HCH_3CO_2(aq) \rightleftharpoons H^+(aq) + CH_3CO_2^-(aq)$

acetic acid — acetate

Solution contains mostly complete molecules

Not all ionic compounds dissolve in water!

- The ones that **do** are strong electrolytes
- The ones that **do not dissolve** remain solid in their ionic lattice when added to water



Solubility Rules for Ionic Compounds
The following table will be given on the exam **without** the formulas in parentheses.

Compounds Containing the Following Ions Are Mostly Soluble	Exceptions
Li^+, Na^+, K^+, NH_4^+	None
nitrate (NO_3^-), acetate ($C_2H_3O_2^-$)	None
chloride (Cl^-), bromide (Br^-), iodide (I^-)	When any of these ions pairs with Ag^+, Hg_2^{2+}, or Pb^{2+}, the compound is insoluble
sulfate (SO_4^{2-})	When sulfate pairs with Sr^{2+}, Ba^{2+}, Pb^{2+}, or Ca^{2+} the compound is insoluble

$Ca(NO_3)_2$ (aq)
$CuSO_4$ (s)
(aq)

Compounds Containing the Following Ions Are Mostly Insoluble	Exceptions
hydroxide (OH^-), sulfide (S^{2-})	When either of these ions pairs with Li^+, Na^+, K^+, or NH_4^+, the compound is soluble
	When sulfide (S^{2-}) pairs with Ca^{2+}, Sr^{2+}, or Ba^{2+}, the compound is soluble
	When hydroxide (OH^-) pairs with Ca^{2+}, Sr^{2+}, or Ba^{2+}, the compound is slightly soluble (for many purposes, these may be considered insoluble)
carbonate (CO_3^{2-}), phosphate (PO_4^{3-})	When either of these ions pairs with Li^+, Na^+, K^+, or NH_4^+, the compound is soluble

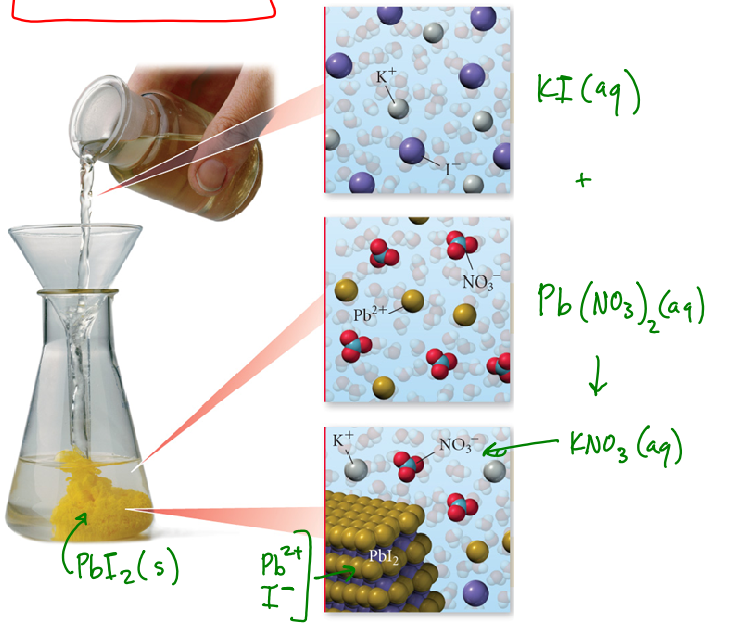
(aq)
(s)

Precipitation reaction: two ionic compounds trade their ions to produce a solid, insoluble product

Write the balanced chemical equation with phase labels for reaction of solutions of potassium iodide and lead(II) nitrate.

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

K^+ I^- Pb^{2+} NO_3^-



$KI(aq)$ +

$Pb(NO_3)_2(aq)$ ↓

$KNO_3(aq)$

$PbI_2(s)$ Pb^{2+} I^-

$aq + aq \rightarrow aq + aq$

If all products are soluble, **NO REACTION** occurs!

Molecular equation: balanced chemical equation showing neutral formulas for all reactants and products.

neutral compounds

$Ca(NO_3)_2(aq) + Na_2SO_4(aq) \rightarrow CaSO_4(s) + 2\,NaNO_3(aq)$

Complete ionic equation: all strong electrolytes are written as separate ions with their own coefficients and phase labels. (Pure solids, liquids, gases, weak electrolytes, and nonelectrolytes written as molecules.)

$Ca^{2+}(aq) + 2\,NO_3^-(aq) + 2\,Na^+(aq) + SO_4^{2-}(aq) \rightarrow$

$CaSO_4(s) + 2Na^+(aq) + 2NO_3^-(aq)$

(insol)

Spectator ions do not participate in the chemical reaction (shown the same on both sides)

$2\,Na^+(aq)$ $2NO_3^-(aq)$

Net ionic equation: omits spectator ions - only shows the chemical change that has occurred

$Ca^{2+}(aq) + SO_4^{2-}(aq) \rightarrow CaSO_4(s)$

(What happens in the net ionic equation when it's considered "no reaction?" Try it for the combination of NaI and $CaNO_3$)

Acid: produces H^+ ions in aqueous solutions
Base: produces OH^- ions in aqueous solutions

Strong acids dissociate completely (they are strong electrolytes) - there are 6 common ones: memorize

- HCl hydrochloric acid
- HBr hydrobromic acid
- HI hydroiodic acid
- HNO_3 nitric acid
- H_2SO_4 sulfuric acid
- $HClO_4$ perchloric acid

Weak acids are other formulas that start with H such as:

- HF (aq)
- $HC_2H_3O_2$ (aq) acetic acid
- H_3PO_4 (aq) phosphoric

stays as HNO_2(aq) in ionic equations (complete or net)

HNO_2(aq) nitrous acid

etc.

Strong bases are the soluble or slightly soluble hydroxides: NaOH, LiOH, KOH, $Ca(OH)_2$, $Ba(OH)_2$

Acid-base neutralization reactions are the combination of an acid and a base to produce water and a salt

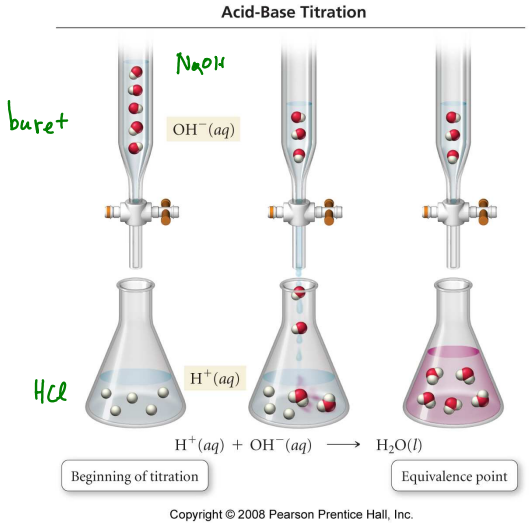
Write an equation for the acid-base neutralization reaction of nitric acid and calcium hydroxide

$2\ HNO_3(aq) + Ca(OH)_2(aq) \longrightarrow 2\ H_2O(l) + Ca(NO_3)_2(aq)$

$(H^+ + OH^- \rightarrow H_2O(l))$

Titration: controlled addition of one reactant (with known concentration) to another to determine an unknown concentration

$HCl(aq) + NaOH(aq) \longrightarrow H_2O(l) + NaCl(aq)$
Net: $H^+ + OH^- \longrightarrow H_2O$

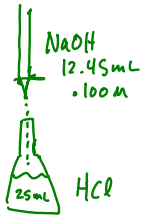


Equivalence point: reaction is complete - equal moles of both reactants completely react with each other

Acid-base indicator: changes color to signal endpoint (phenolphthalein changes pink in excess OH^-)

Titration problem

25.0 mL of HCl(*aq*) of unknown concentration were titrated with 12.45 mL of 0.100 M NaOH(*aq*). What is the molarity of the HCl(*aq*)?



(1) HCl(*aq*) + NaOH(*aq*) → $H_2O(l)$ + NaCl(*aq*)

$M(HCl) = \frac{\text{mol HCl}}{\text{L solution}}$

$25.0\text{ mL} \times \frac{\text{L}}{1000\text{ mL}} = .0250\text{ L}$

$12.45\text{ mL NaOH} \times \frac{1\text{ L}}{1000\text{ mL}} \times \frac{.100\text{ mol NaOH}}{1\text{ L NaOH soln}} \times \frac{1\text{ mol HCl}}{1\text{ mol NaOH}} = 1.245 \times 10^{-3}\text{ mol HCl}$

$M(HCl) = \frac{1.245 \times 10^{-3}\text{ mol HCl}}{.0250\text{ L HCl}} = \boxed{0.0498\text{ M HCl}}$

Gas-evolution reactions

Sulfides, sulfites, and carbonates form a gaseous product when reacting with an acid

$2HCl(aq) + Na_2S(aq) \rightarrow \boxed{H_2S(g)} + 2NaCl$

acid + sulfide → hydrogen sulfide gas

$HCl(aq) + Na_2SO_3(aq) \rightarrow \boxed{H_2SO_3(aq)} + NaCl(aq)$

acid, sulfite

$\rightarrow H_2O(l) + \boxed{SO_2(g)}$

$\rightarrow H_2O(l) + SO_2(g) + NaCl(aq)$

products

$HCl(aq) + Na_2CO_3(aq) \rightarrow \boxed{H_2CO_3(aq)} + NaCl$

acid, carbonate

$\rightarrow H_2O(l) + CO_2(g)$

$\rightarrow H_2O(l) + CO_2(g) + NaCl(aq)$