

Example (cont'd.)

- How many moles of Ag⁺ left in the solution?

Solubility and Stoichiometry

What mass of solid NaCl must be added to 1.50 L of a 0.100 M AgNO₃ solution to precipitate all of the Ag⁺?

Acid-Base Reactions

Generally, in an acid-base reaction,

- H⁺ from acid reacts with the OH⁻ from base to form water H₂O
- The cation (M⁺) from base combines with anion from acid (X⁻) to form a salt.

A general equation for an acid-base neutralization reaction is shown below:



Acid-Base Rxns

Bronsted-Lowry Theory: acid/base reactions are proton-transfer processes.

- acid** is **proton-donor** (H⁺ ion donor).
- base** is **proton-acceptor** (H⁺ ion acceptor).



When an **acid** gives its proton to water, water is acting as a **base**.



When a **base** accepts a proton from water, water is acting as an **acid**.



Strong and Weak Acids

- Strong acids (think "strong electrolyte") undergo complete ionization.

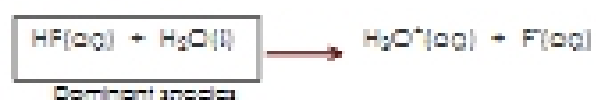
- For HCl, essentially all the HCl molecules split up into ions.



- Weak acids (think "weak electrolyte") undergo incomplete ionization.

- For HF, only a very few H^+ and F^- ions exist in solution...the reverse reaction dominates the chemistry.

- Weak acids are like insoluble salts...they don't like to dissociate very much.



Strong and Weak Acids

- Strong acids to know:

- Two well-known oxyacids: nitric (HNO_3), sulfuric (H_2SO_4)
- Group 7 acids: hydrochloric (HCl), hydrobromic (HBr), hydroiodic (HI)
- Two chlorine oxyacids: chloric (HClO_3), perchloric (HClO_4)

Any other acids we see in this course will be weak.

- Polyprotic acids lose only their first H^+ easily, producing $\text{H}_2\text{O}^+(\text{aq})$ and an acid anion:



The acid anion of sulfuric acid, the hydrogen sulfate anion, is also an acid, but it does not dissociate as readily as sulfuric acid...it is a weak acid.

Selected Acids and Bases

Acids	Bases
Strong: $\text{H}^+(\text{aq}) + \text{A}^-(\text{aq})$ hydrochloric, HCl hydrobromic, HBr hydroiodic, HI nitric acid, HNO_3 sulfuric acid, H_2SO_4 chloric acid, HClO_3 perchloric acid, HClO_4	Strong: $\text{M}^+(\text{aq}) + \text{OH}^-(\text{aq})$ *(M is Group I or II metal) lithium hydroxide, LiOH sodium hydroxide, NaOH potassium hydroxide, KOH calcium hydroxide, $\text{Ca}(\text{OH})_2$ strontium hydroxide, $\text{Sr}(\text{OH})_2$ barium hydroxide, $\text{Ba}(\text{OH})_2$
Weak hydrofluoric, HF phosphoric acid, H_3PO_4 acetic acid, CH_3COOH	Weak ammonia, NH_3 (accepts proton from water to form $\text{NH}_4^+(\text{aq})$ and $\text{OH}^-(\text{aq})$)

Writing Balanced Equations for Neutralization Reactions - I

Write balanced equations (molecular, total ionic, and net ionic) for the following chemical reactions:

- calcium hydroxide (aq) and hydroiodic acid (aq)
- lithium hydroxide (aq) and nitric acid (aq)
- barium hydroxide (aq) and sulfuric acid (aq)

Acid/Base and Stoichiometry

What volume of 0.125 M HCl is needed to neutralize 200.0 mL of a 0.00955 M $\text{Ca}(\text{OH})_2$ solution?

Acid/Base and Limiting Reagent

75.0 mL of 0.250 M HCl is added to 225.0 mL of 0.0550 M $\text{Ba}(\text{OH})_2$ solution. What is the concentration of the excess H^+ or OH^- ions left in this solution?



1. How many moles of each reactant?
2. Which is limiting?
3. How much H^+ or OH^- is left over?
4. What is the new volume?
5. What is the concentration of the excess reactant?

Acid / Base Titrations

An application of stoichiometry

- Sometimes we need to know information about an acid or a base – exact molarity.
- This is important for chemicals that are hard to weigh out (example: solid NaOH absorbs water from the air)
- Titrate it with a known solution!



What we want to know about goes here

What we know already goes here

Acid / Base Titrations

Example: Titrating an unknown concentration of NaOH solution with 0.500 M HCl solution

HCl is added slowly from the buret to the solution of NaOH in the flask.



An indicator is added that changes color when moles of HCl = moles of NaOH. This is the equivalence point.

Read the volume of HCl solution added – now you know the moles of HCl and the moles of NaOH

