

Basic Chemistry Concepts

Basic chemistry concepts

- Chemistry – basics of the basics
- Chemical reactions
- Equilibrium chemistry
- Reaction kinetics
- Concentration units in water
- Carbonate system

Mole & molarity

- Mole = Avogadro's number (6.02×10^{23}) of molecules
- Molarity (M) = number of moles per liter of solution (mole/L)
cf) molality (m) = number of moles per kg of solvent

Activity

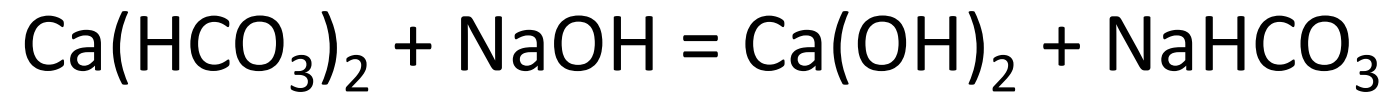
- Determines the tendency for a reaction to occur
- Represented by $\{ \}$ (cf. molarity by $[]$)
- In dilute aqueous solutions, the ions do not significantly interact with one another:

$$\{i\} \approx [i]$$

- As concentration increases, the ion-ion interaction becomes more significant:

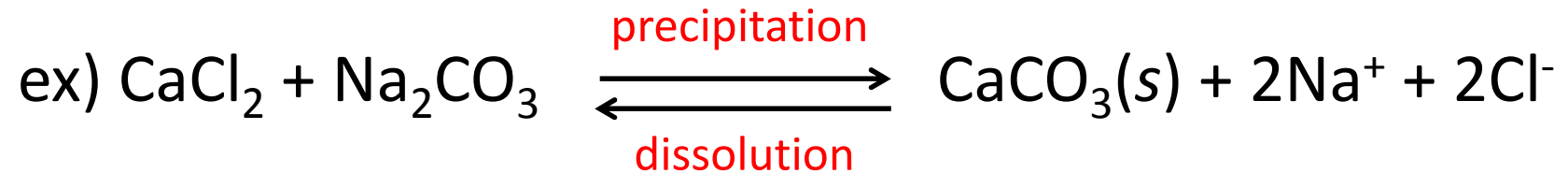
$$\{i\} = \gamma_i \cdot [i] \quad \text{where } \gamma_i = \text{activity coefficient}$$

Balancing chemical reactions



Types of chemical reactions

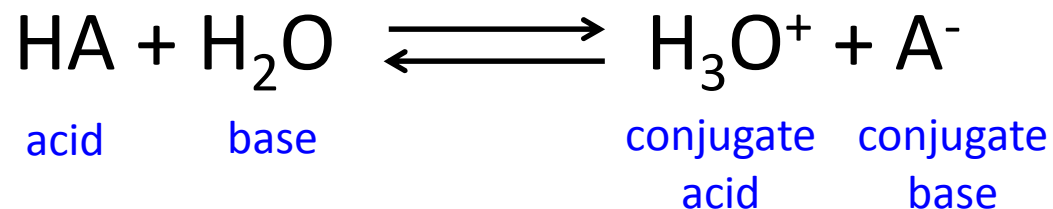
- Precipitation-dissolution reactions



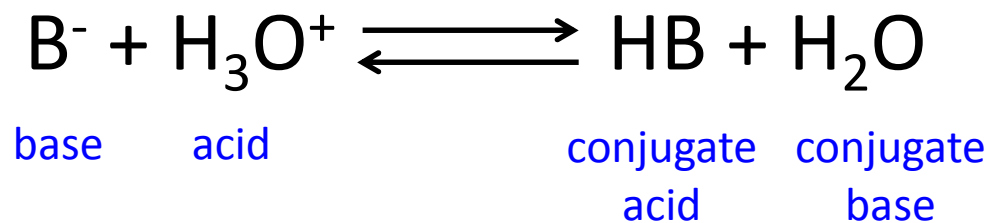
Usage: softening, phosphorous removal, heavy metal removal

Acid-base reactions

- Brønsted-Lowry acid: any substance that can donate a proton (i.e., proton donor)

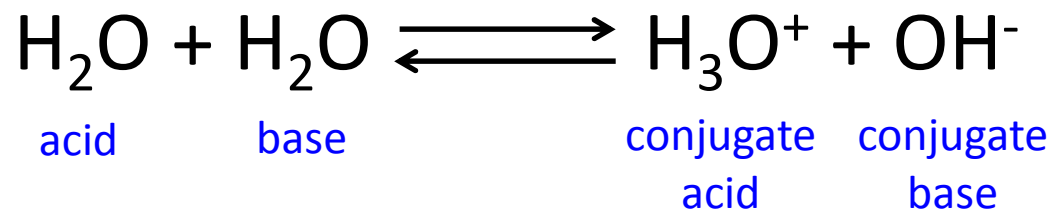


- Brønsted-Lowry base: any substance that can accept a proton (i.e., proton acceptor)



Acid-base reactions

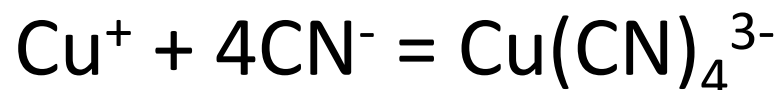
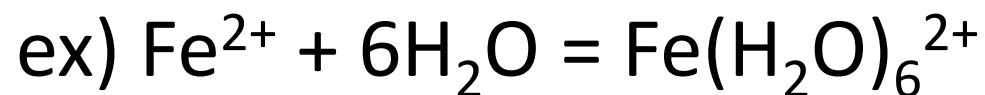
- Water is amphoteric – can be either an acid or a base



- $\text{pH} = -\log\{\text{H}^+\}$ (“p” denotes “-log”)

Complexation reactions

- Coordination of two or more atoms, molecules, or ions resulting in the formation of a more stable product



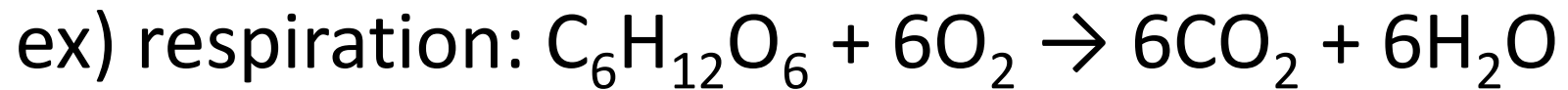
- Complex ion = a metal ion (Lewis acid) coordinated with ligands (Lewis bases)

Complexation reactions

- Many metal ions exist as complex ions in water (metal aquo complex)
ex) $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$, $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$, $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$,
 $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$, $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$, $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$
- Environmental significance: complexation of metals affects the uptake, biodegradability, toxicity, and mobility of the metal

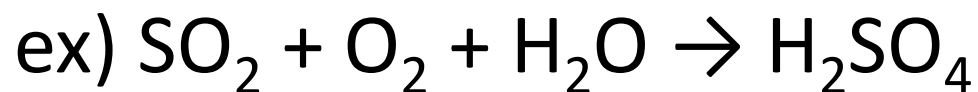
Oxidation-reduction (redox) reactions

- Involves changes in the oxidation state
- Essential for life: photosynthesis and respiration are redox reactions!



Oxidation-reduction (redox) reactions

- Balancing redox reactions: have to consider electron balance in addition to atom balance!



Reading assignment

- Textbook Ch2 p. 32-43