Class #8
Reactions in Solution: Acids & Bases

CHEM 107
L.S. Brown
Texas A&M University

Acids

• What’s an acid?
• Early Observations (17th century)
• Acids:
  powerful solvents
  change colors of dyes
  sour taste

Bases

• What’s a base?
• Observations:
• Bases
  slippery, “soapy” feel
  change colors of dyes, but differently than acids
  bitter taste
Acids & Bases

- Mixing acid + base eliminates the properties of both
- “Neutralization”

Molecular View

- Acids in water form $\text{H}_3\text{O}^+$ ions. (“hydronium ions”)
- Bases in water form $\text{OH}^-$ ions. (“hydroxide ions”)
- Neutralization?
  $$\text{H}_3\text{O}^+ + \text{OH}^- \rightarrow 2 \text{H}_2\text{O}$$

Strong vs. Weak

- Strong acids - dissociate completely in solution
  $$\text{HCl} + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{Cl}^-$$
- "One-way" arrow means all HCl breaks up into ions
- Solution contains $\text{H}_3\text{O}^+$, $\text{Cl}^-$, and $\text{H}_2\text{O}$, but not HCl
Strong Acid Solution: HCl

\[ \text{HCl} + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{Cl}^- \]

\( \bullet \) \( = \text{H}_3\text{O}^+ \)
\( \bullet \) \( = \text{Cl}^- \)

NO intact HCl present!

Strong vs. Weak

- Weak acids - dissociate only partially. Some molecular acid remains.
  \( \text{CH}_3\text{COOH} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{CH}_3\text{COO}^- \)
- "Two-way" arrow means some on each side
- \( \text{H}_3\text{O}^+ \), \( \text{CH}_3\text{COO}^- \), and \( \text{CH}_3\text{COOH} \) all present

Weak Acid: \( \text{CH}_3\text{COOH} \)

\[ \text{CH}_3\text{COOH} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{CH}_3\text{COO}^- \]

\( \bullet \) \( = \text{H}_3\text{O}^+ \)
\( \bullet \) \( = \text{CH}_3\text{COO}^- \)
\( \bullet \) \( = \text{CH}_3\text{COOH} \)
Strong Acids

- HCl, HBr, HI, HNO₃, HClO₄, H₂SO₄
- Some weak acids, like HF, are very reactive
- Also note that strong does not refer to concentration

Bases

- Strong and weak ideas work for bases, too
- Strong bases are metal hydroxides: NaOH, Ba(OH)₂, etc.
- Dissociate completely:
  - NaOH → Na⁺ + OH⁻
  - Ba(OH)₂ → Ba²⁺ + 2 OH⁻

Weak Bases

- Weak bases: react only partially, still make OH⁻
- NH₃ is an example
- How does it produce OH⁻?
  - NH₃ + H₂O ⇄ NH₄⁺ + OH⁻
Recall: Molarity

- Molarity: common unit of concentration
  \[ \text{molarity} = \frac{\text{moles of solute}}{\text{liters of solution}} \]
- So measuring volume lets us find # of moles

Solution Stoichiometry

- AS ALWAYS, focus on moles
- Use molarity and volume to find number of moles
  \[ \text{molarity} = \frac{\text{moles per liter}}{} \]
  so:
  \[ \text{molarity} \times \text{volume} = \text{moles} \]

Dilution

- We often make solutions from concentrated “stock solutions,” by adding more solvent
- In some of your labs you will need to dilute solutions and know concentrations
Dilution Example

- You have a large bottle of 0.25 M CuSO₄ solution, and you need to make 100 mL of 0.10 M solution.
- How much of the 0.25 M solution should you use?

2 Al(s) + 2 KOH(aq) + 6 H₂O(l) → 
       2 KAl(OH)₄(aq) + 3 H₂(g)

A standard 12-ounce soft drink can contains approximately 15.0 g of aluminum. What volume of 1.25 M KOH would be required to dissolve the aluminum from such a can? Please express your answer in milliliters.