Chap 7

ACIDS and BASES

1. a) **Definition** - Latin (acidus) = sour, vinegar and lemons.

   Arrhenius definition – Acid produces H⁺

   \[ HX \rightarrow H^+_{(aq)} + X^-_{(aq)} \]
   \[ HBr \rightarrow H^+_{(aq)} + Br^-_{(aq)} \]

   b) Bases- are ionic compounds that separate to give a metal ion and hydroxide ions.

   \[ KOH \rightarrow K^+_{(aq)} + OH^-_{(aq)} \]

2. **Further defining** acids and bases. Bronsted-Lowry Acid and bases.

   Acid- donates a proton (H⁺)
   base- accepts a proton (H⁺)

   \[ H_2O + HBr \rightarrow H_3O^+ + Br^- \]

   base         acid         acid         base

   \[ NaOH + H_2O \rightarrow H_2O + OH^-_{(aq)} + Na^+_{(aq)} \]

   Base         Acid         Acid         Base
3. Formation of Acids and Base

a) Non-metal oxides: formation of acid.

General equation: Non-metal oxide + H₂O → acid

Ex. SO₃ + H₂O → H₂SO₄

Ex. CO₂ + H₂O → H₂CO₃

Leads to acid rain: rain is slightly acidic because of carbon dioxide in the air.

Pollutants such as SO₂ and from burning high sulfur coal and metal smelters. Also volcanoes give off sulfur oxides

S + O₂ → SO₂
2SO₂ + O₂ → 2SO₃
SO₃ + H₂O → H₂SO₄

marble 2H⁺ + CaCO₃ → CO₂ + H₂O + Ca²⁺

NO from and NO₂ from car exhaust and from lightening.

b) Bases can be made from Metal Oxides:

metal oxide + H₂O → base
Ex. CaO + H₂O □ Ca(OH)₂

Ex. Li₂O + H₂O □ 2LiOH

4. Strengths of Acids and Bases
   a) Acids
      1) Strong Acids- ionize completely
         Group 7A      HCl, HBr, HI
         Oxyacids      HNO₃, H₂SO₄

         H₂O + HNO₃ □ H₃O⁺ + NO₃⁻(aq)
         0%           100%

      2) Weak Acids – Ionize very little
         HC₂H₃O₂ + H₂O ⇌ C₂H₃O₂⁻ + H₃O⁺
         98%           2%

         HF + H₂O ⇌ F⁻(aq) + H₃O⁺

   b) Bases
      1) Strong bases- ionize completely to give metal ions and hydroxide (OH⁻)
         Group 1A and Ba are strong Bases.
         H₂O
         KOH □ K⁺(aq) + OH⁻

      2) Weak Bases – produce few hydroxide ions
         N₃⁻ + H₂O ⇌ N₄⁺ + OH⁻
         Base     Acid     Acid     Base

5. Acid- Base Neutralization
   A) Net ionic

      Mix: Acid + Base □ water + salt neutralization
Strong acid, strong base always get \( H^+ + OH^- \rightarrow H_2O \)

**Ex.:** HCl + NaOH \( \rightarrow \) NaCl\(_{(aq)} \) + H\(_2\)O

\[ H^+ + Cl^-\_(aq) + Na^+\_(aq) + OH^-\_(aq) \rightarrow Cl^-\_(aq) + Na^+\_(aq) + H_2O \]

Net Ionic: \( H^+ + OH^-\_(aq) \rightarrow H_2O \) strong acid, strong base

**Ex.:** 2HBr + Ba(OH)\(_2\) \( \rightarrow \) Ba(Br)\(_2\)\(_{(aq)}\) + 2 H\(_2\)O

\[ 2H^+ + 2Br^-\_(aq) + Ba^{2+}\_(aq) + 2OH^-\_(aq) \rightarrow Br^-\_(aq) + Ba^{2+}\_(aq) + H_2O \]

Net Ionic: \( H^+ + OH^-\_(aq) \rightarrow H_2O \) strong acid, strong base

6. **pH scale, pOH**

\( \text{pH} = 7 \) neutral \hspace{1cm} \( \text{pOH} = 7 \) neutral
\( \text{pH} > 7 \) basic \hspace{1cm} \( \text{pOH} > 7 \) acidic
\( \text{pH} < 7 \) acidic \hspace{1cm} \( \text{pOH} < 7 \) basic

show overhead of pH values

\[ \text{pH} = -\log[H_3O^+] \hspace{1cm} \text{invlog}(-\text{pH}) = [H_3O^+] \]

\[ K_w = [H_3O^+][OH^-] = [1.0 \times 10^{-7}][1.0 \times 10^{-7}] \]

\[ \text{pH} = -\log[1.0 \times 10^{-7}] = 7 \]

\[ \text{pH} + \text{pOH} = 14 \]

7. **Antacids:** stomach is full of HCl and can get too much, hyperacidity. Body very important to maintain correct pH, acids and bases will destroy proteins.

Most common:

1. NaHCO\(_3\) (baking soda) good but too much can make the blood alkaline.
2. CaCO\(_3\) regular use can cause constipation and may actually result in increased acid secretion after a few hours.
3. Al(OH)₃ too much can cause constipation and aluminum ions can deplete the body of essential phosphate ions.
4. Mg(OH)₂ suspended in water is milk of magnesia in large doses can act as a laxative.

8. Industrial use.

   a) most common chemical in the US by far is sulfuric acid. 40 billion kg. used for fertilizers and other uses