Acids and Bases

- Acids and bases, as we use them in the lab, are usually aqueous solutions.
  - Ex: when we talk about “hydrochloric acid”, it is actually hydrogen chloride gas dissolved in water
    - $HCl_{(aq)}$
- Concentrated acids have large molarities
  - Ex: “conc.” HCl = 12M; H_2SO_4 = 18M
- In the lab, we usually use dilute solutions
  - Ex: 1.0M HCl, or 0.1M H_2SO_4

Electrolytes

- Substances that, when dissolved in water, produce aqueous solutions that will conduct electricity
- Strong electrolytes release many ions
  - Many ionic compounds
- Weak electrolytes release few ions

Autoionization of water

- Water molecules can react with each other
- $H_2O + H_2O \rightleftarrows H_3O^+ + OH^-$
- At 25ºC, $[H_3O^+] = [OH^-] = 1x10^{-7}M$
- $[H_2O]$ is a constant
- $K_w = [H_3O^+] [OH^-] = 1x10^{-14}$

- Let's use [H+] instead of [H_3O^+]
- Pure water is **neutral**

That means **[H^+] = [OH^-]** = 1×10^{-7}M

If [H^+] > [OH^-], the solution is acidic

If [H^+] < [OH^-], the solution is basic

pH scale

- Used to indicate how acidic ($[H^+]$) or basic ($[OH^-]$) a solution is
- **the <u>lower</u> the pH, the more H^+'s in the water, the <u>more acidic</u> the solution**
- tells how strongly acidic a *solution* is - NOT how strong an *acid* is!

pH scale (7 = neutral)

- 0 - 2
  - strongly acidic
- 2 - 4
  - moderately acidic
- 4 – 6.99
  - weakly acidic
- 7.01 - 10
  - weakly basic
- 10 - 12
  - moderately basic
- 12 - 14
  - strongly basic

What is an acid?

Brønsted/Lowry acid: a proton donor

proton donor?...

a proton is also an H^+ ion

in water, H_2O + donated $H^+ \rightarrow H_3O^+$

- H_3O^+ = "hydronium ion"

Properties of acids

- React with most metals to produce $H_{2(g)}$
- react with carbonates to produce CO_2
- taste sour
- damage living tissues
- pH 0 - 7
- neutralize bases

Common acids

- Acid formulas – usually start with H
- HCl – hydrochloric acid (strong)
- H_2SO_4 – sulfuric acid (strong)
- HNO_3 – nitric acid (strong)
- $HClO_4$ – perchloric acid (strong)
- H_3PO_4 – phosphoric acid
- $HC_2H_3O_2$ – acetic acid
  - Also written CH_3COOH

pH calculation

$$pH = -\log [H^+]$$

$$[H^+] = 10^{-pH}$$

pH scale

- The pH is the measurement of how many H^+'s are in the water – NOT a measure of whether the H^+'s came from a "strong" or "weak" acid!!!

Acid Strength

- Strong acids <u>release all</u> of their H^+ ions
  - [strong acid] = $[H^+]$
  - Strong acids are strong electrolytes
- Weak acids <u>hold on to most</u> of their H^+ ions
  - [weak acid]>>>$[H^+]$
  - Weak acids are weak electrolytes
  - Weak acids reach equilibrium with “neutralization” products

Acid Strength

Compare the difference in these two statements:

1) The more H^+ ions in the water, the more *acidic the solution*
2) The more H^+ ions a compound produces, the *stronger the acid*

Don't get confused!

- A solution of a strong acid can actually be *less acidic* than a solution of a weak acid!
- IF: the *strong acid solution is very dilute* and the *weak acid is concentrated!*

- ex: HCl is a strong acid, but if in a solution [HCl] = 1×10^{-6}M, the pH = 6 $\Rightarrow$ and it is a *weakly acidic solution* of a *strong acid*.

Put it another way…

"Acids" don't have a pH…

…SOLUTIONS have a pH…

and ACIDIC solutions *have a pH less than 7*

Ex: HCl is a ***strong acid***, but…

- 1.0M HCl $\rightarrow$ pH = 0.0
- 0.1M HCl $\rightarrow$ pH = 1.0
- 0.0001M HCl $\rightarrow$ pH = 4.0
- 0.000001M HCl $\rightarrow$ pH = 6.0

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