Review

Acids: donate H^+ (lose)
Bases: accept H^+ (gain)

1. $OH + HCN \longrightarrow H_2O + CN^-$

BB BA CA CB

2. $HPO_4^{2-} + H_2O \longrightarrow OH^- + H_2PO_4$

BB BA RB CA

3. $HF + H_2O \longrightarrow H_3O^+ + F$

BA BB CA CB

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K_w

- K_w = ion production constant for water
- water breaks down to give H^+ and OH^-
  - *H_2O (l) --> H^+ (aq) + OH^- (aq)*
- $K_w = [H^+][OH^-]$
- $K_w = 1 \times 10^{-14} = [H^+][OH^-]$
- So, $[H^+]$ and $[OH^-]$ have an indirect relationship

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Practice

[ ] = concent. (M)

- What is the $[OH^-]$ when the $[H^+] = 1 \times 10^{-6}$?

$1 \times 10^{-14} = [H^+][OH^-]$ ←

$$\frac{1 \times 10^{-14}}{1 \times 10^{-6}} = \frac{(1 \times 10^{-6})[OH^-]}{1 \times 10^{-6}}$$

$= 1 \times 10^{-8} M$

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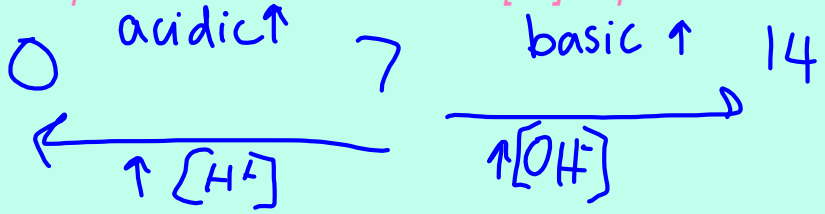
pH:

0-14 pH scale

- **pH = -log $[H^+]$**
- **acids have a pH < 7 (less than)**
- **bases have a pH > 7 (more than)**
- **neutral has a pH = 7**
- **Increases by a factor of 10 between numbers on the pH scale**
  - *pH of 3 has ten times the $[H^+]$ of pH 4*



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pOH:

- **pOH = -log [OH^-]**
- acids have pOH > 7
- bases have a pOH <7
- neutral has a pOH = 7
- Increases by a factor of 10 between numbers on the pOH scale
  - *pOH of 3 has ten times the [OH^-] of pOH 4*

1×10^{-7} 1×10^{-7} $= 1 \times 10^{-14}$

$[H^+] = [OH^-]$

0 basic ↑ 7 acidic ↑ 14

← $[OH^-]$ ↑ $[H^+]$ →

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pH and pOH:

14 = pH + pOH

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pH Practice

- Calculate the pH of solutions having the following ion concentrations at 298K.
  - > $[H^+] = 1.0 \times 10^{-2}$ M

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

    $pH = -\log 1 \times 10^{-2}$

    $pH = 2$
  - > $[OH^-] = 8.6 \times 10^{-6}$ M

    $pOH = -\log 8.6 \times 10^{-6}$

    $pOH = 5.1$

    ~~$pH = 5.1$~~

    $14 = pH + pOH$

    $14 - 5.1 = 8.9 = pH$

Which of the solutions is more acidic? 1st

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pOH Practice

- Calculate the pOH of solutions having the following ion concentrations at 298K.
  - > $[OH^-] = 3.75 \times 10^{-6}$ M

    $pOH = -\log[OH^-]$

    $pOH = -\log 3.75 \times 10^{-6}$

    $pOH = 5.4$
  - > What is the pH of a solution with a pOH of 12.5?

    $14 = pH + pOH$

    $14 - 12.5 = pH$

    $pH = 1.5$

Which of the solutions is more acidic?

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Finding Ion Concentration

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

$[OH^-] = 10^{-pOH}$

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Practice

- Calculate the $[H^+]$ and the $[OH^-]$ in a solution with a pH of 2.37.

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

$[H^+] = 10^{-2.37}$

$[H^+] = .004M$

$[OH^-] = 10^{-pOH}$

$14 - 2.37 = 11.63$

$[OH^-] = 10^{-11.63}$

$[OH^-] = 2.34 \times 10^{-12} M$

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Practice

- Calculate the $[H^+]$ of a solution with a pOH of 8.5.

$14 - 8.5 = 5.5$

$[H^+] = 10^{-pH} = 10^{-5.5}$

$[H^+] = 6.16 \times 10^{-6} M$

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Strength of Acids and Bases

- Dilute and Concentrated: refer to the # of moles of acid or base dissolved in a volume of solution
- Weak and Strong: refers to degree of ion formation
  - > Strong acids and bases completely ionize (also called strong electrolytes)
    - – *ex:* $HCl \rightarrow H^+ + Cl^-$
  - > Weak acids and bases have incomplete ionization (establish equilibrium)
    - – *ex:* $HC_2H_3O_2 \leftrightarrow H^+ + C_2H_3O_2^-$

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Strength of Acids and Bases

- Strong Acids: HCl, HI, HBr, HNO_3, H_2SO_4, $HClO_4$
- Strong Bases: LiOH, NaOH, KOH, RbOH, $Ca(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$
- Any acids or bases not on this list are weak!

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Strength of Acids and Bases

- K_a = acid ionization constant = the value of the equilibrium constant expression for the ionization of a weak acid
- weakest acids have the smallest K_a value

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Strength of Acids and Bases

- K_b = base ionization constant = the value of the equilibrium constant expression for the ionization of a weak base
- weakest bases have the smallest K_b value

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Calculating the pH of Strong Acids and Bases

- For all strong monoprotic acids, the concentration of the acid is the concentration of the H^+
- For all strong bases, the concentration of the base is the concentration of the OH^-

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Strong Acids and Bases Practice

- Calculate the pH and pOH of the following solutions:
  - 0.10 M HI

$pH = -\log(.10) = 1 = pH$

$14 - 1 = 13 = pOH$

  - 2.4×10^{-5} M KOH

$pOH = -\log 2.4 \times 10^{-5}$

$pOH = 4.6$

$14 - 4.6 = 9.4 = pH$

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Measuring pH

- pH paper: will change the color depending on the hydrogen ion concentration in solution, the color is then compared to a standard scale
- pH meter: more accurate than pH paper, contains electrode that are immersed in solution, will give a digital readout

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