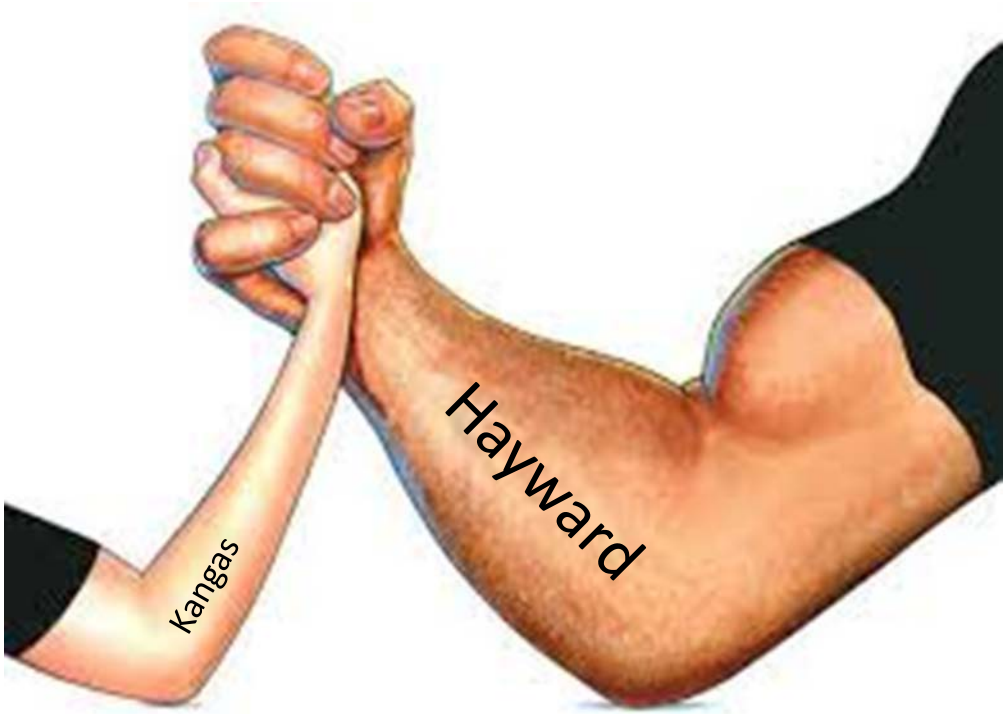
Weak & Strong Acids & Bases…



Outcomes:

- Distinguish between weak and strong solutions of acids and bases.

Strong Acids:

- Acids that easily **DONATE PROTONS**.
- They **DISSOCIATE COMPLETELY** in water (**WEAK HOLD** on H^+).
- Are usually **STRONG ELECTROLYTES**.
- **DISSOCIATION** equations use a **SINGLE ARROW** → Will **NOT** establish an **EQUILIBRIUM**

Example:

At start: $HCl_{(g)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + Cl^-_{(aq)}$

100% 0% 0%

At Eq.: $HCl_{(g)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + Cl^-_{(aq)}$

0% 100% 100%

$K_{eq} = \frac{[H_3O^+][Cl^-]}{[HCl]} = \frac{(100)(100)}{0}$

Strong Acid Ionization Animation

Examples of strong acids you should know:

HNO_3 – **NITRIC ACID**

H_2SO_4 – **SULFURIC ACID**

HBr – **HYDROBROMIC ACID**

HCl – **HYDROCHLORIC ACID**

$HClO_4$ – **PERCHLORIC ACID**

HI – **HYDROIODIC ACID**

Weak Acids:

- **DO NOT IONIZE COMPLETELY** in water (**STRONG HOLD** on H^+).
- Are **POOR ELECTROLYTES**.
- **DISSOCIATION** equations use a **DOUBLE ARROW**.
- Establish an **EQUILIBRIUM**

Example: $HC_2H_3O_2$ $C_2H_3O_2^-$

At start: $CH_3COOH_{(aq)} + H_2O_{(l)} \leftrightarrows H_3O^+_{(aq)} + CH_3COO^-_{(aq)}$

100% **0%** **0%**

At Eq: $CH_3COOH_{(aq)} + H_2O_{(l)} \leftrightarrows H_3O^+_{(aq)} + CH_3COO^-_{(aq)}$

99% **1%** **1%**

Weak Acid Ionization Animation

Examples of weak acids you should know:

HNO_2 – **NITROUS ACID** H_2CO_3 – **CARBONIC ACID**

CH_3COOH – **ACETIC ACID** HF – **HYDROFLUORIC ACID**

$HC_2H_3O_2$

Strong Bases:

- Have a **HIGH AFFINITY** for H^+ as they Usually **DISSOCIATE** into **OH^- or O^{2-}**, which have a strong "**HUNGER**" for H^+.
- Are **STRONG ELECTROLYTES** → **COMPLETELY DISSOCIATE** (single arrow)
- Will **NOT** establish an **EQUILIBRIUM**

Examples:

$$NaOH_{(s)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$$

$$KOH_{(s)} \rightarrow K^+_{(aq)} + OH^-_{(aq)}$$

Examples of strong bases you should know:

$Mg(OH)_2$ – **MAGNESIUM HYDROXIDE**
CaO – **CALCIUM OXIDE (LIME)**
$Ca(OH)_2$ – **CALCIUM HYDROXIDE**
Na(OH) – **SODIUM HYDROXIDE**
KOH – **POTASSIUM HYDROXIDE**

Rule of thumb: ***1st and 2nd group hydroxides are always strong bases***

Weak Bases:

- Are poor H^+ **ACCEPTORS**.
- Are **WEAK ELECTROLYTES** → not **COMPLETE DISSOCIATION**.
- Will establish an **EQUILIBRIUM**

Examples:

$$NH_{3(g)} + H_2O_{(l)} \leftrightarrow NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$$

$$Al(OH)_{3\,(s)} \leftrightarrow Al^{3+}{}_{(aq)} + 3OH^-{}_{(aq)}$$

Strong vs. Weak:

The terms strong & weak refer to the **EXTENT** that an **ACID** or **BASE** **IONIZES**.

Example:

- HCl is a **STRONG** **ACID**, and **IONIZES** **100**%
- **GASTRIC** **JUICE** in the **STOMACH** is a dilute solution of HCl.
- A relatively **SMALL** **AMOUNT** of HCl is **PRESENT**, but **ALL** the **MOLECULES** **DISSOCIATE** into ions.

Question:

Can you have a **CONCENTRATED** **WEAK** acid?

YES! Acids like CH_3COOH dissolve well, but ionize only slightly.

Acid Strength Table:

We have a table that shows the relative strengths of acids and bases.

→ See Table.

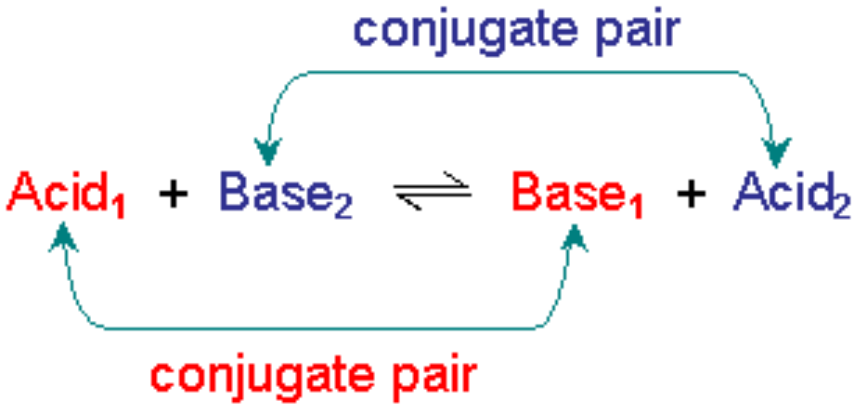
As you move **DOWN** the table, the **STRENGTH** of the **ACID DECREASES**, and **STRENGTH** of **BASE INCREASES**.

Recall conjugate acids and bases. Notice from the table that:

- ***The stronger the acid, the weaker the conjugate base***
- ***The weaker the acid, the stronger the conjugate base.***

Acid Strength Table:

Recall, an acid donates a proton and a base accepts the proton.



The **STRONGER** of the two acids will **DONATE** its **PROTON**. Therefore, the reaction will **FAVOUR** the direction **AWAY** from the **STRONGEST ACID**.

Example Problems:

1. Use the acid strength chart to arrange the following in order of decreasing strength of acid, and decreasing strength of base:

   HNO_2, OH^-, HCO_3^-, HPO_4^{2-}, HTe^-, $C_2H_3O_2^-$

Solution…

STRONG ⟶ WEAK

Acids HNO_2, HCO_3^-, HTe^-, HPO_4^{2-}, OH^-

BASES OH^-, HPO_4^{2-}, HCO_3^-, $C_2H_3O_2^-$, HTe^-

Example Problems:

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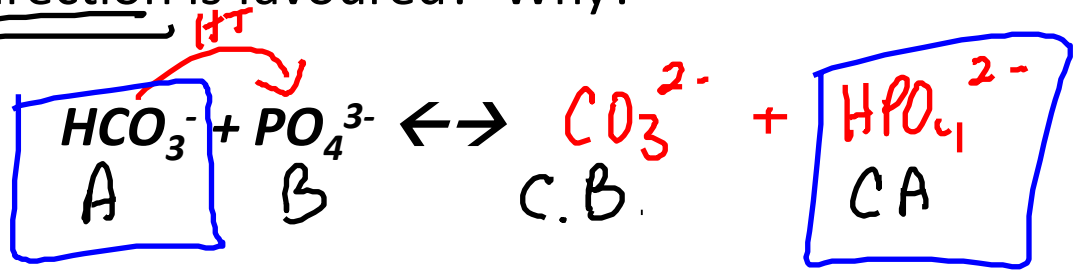
2. Complete the reaction below, indicate the acids and bases. Which direction is favoured? Why?



Solution…

STRONGER Acid →

FWD FAVOURED

Try this one:

Complete the reaction below, indicate the acids and bases. Which direction is favoured? Why?