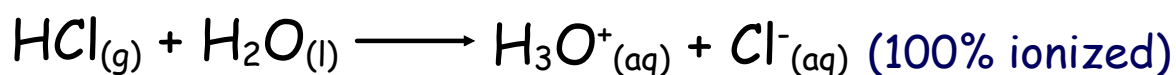


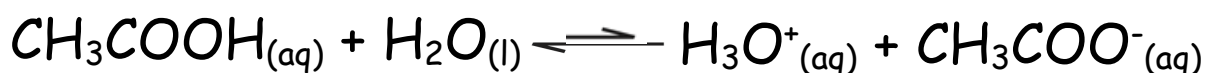
# Strengths of Acids

## Strong and Weak Acids and Bases

Acids are classified as strong or weak depending on the degree to which they ionize in water. In general, **strong acids** are completely ionized in aqueous solution.



Weak acids ionize only slightly in aqueous solution.



In this reaction, fewer than 1% of ethanoic acid ( $\text{CH}_3\text{COOH}$ ) molecules are ionized at any instant. Therefore, ethanoic acid is considered to be a weak acid.

Table 19.6 (pg. 605) shows the relative strengths of some common acids and bases.

We can write the equilibrium constant expression from the balanced chemical equation. The  $K_{eq}$  for ethanoic acid would be.

$$K_{eq} = \frac{[H_3O^+] \times [CH_3COO^-]}{[CH_3COOH] \times [H_2O]}$$

For dilute solutions,  $K_{eq}$  can be combined with water to give an **acid dissociation constant ( $K_a$ )**.

$$K_{eq} \times [H_2O] = K_a = \frac{[H_3O^+] \times [CH_3COO^-]}{[CH_3COOH]}$$

$K_a$  reflects the fraction of an acid in the ionized form.

In general, 
$$K_a = \frac{[H^+][A^-]}{[HA]}$$

where  $[A^-]$  is the negative ion from the dissociation and  $[HA]$  is the acid.

Weak acids have small  $K_a$  values. The stronger an acid is, the larger is its  $K_a$  value.

For example, nitrous acid ( $\text{HNO}_2$ ) has a  $K_a$  value of  $4.4 \times 10^{-4}$ , where ethanoic acid has a  $K_a$  value of  $1.8 \times 10^{-5}$ . This means that nitrous acid is a stronger acid than ethanoic acid.

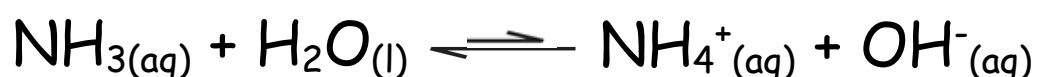
Diprotic and triprotic acids lose their hydrogens one at a time. Each ionization reaction has a separate  $K_a$  value.

Looking at the table on page 607, as hydrogens are lost in ionization, what is the trend in  $K_a$ ?

Just as there are strong and weak acids, there are also strong and weak bases.

**Strong bases** dissociate completely into metal ions and hydroxide ions.

**Weak bases** react with water to form the hydroxide ion and the conjugate acid of the base.



Using this weak base example, we can set up a similar constant for bases that was done for acids.

$$K_{eq} = \frac{[\text{NH}_4^+] \times [\text{OH}^-]}{[\text{NH}_3] \times [\text{H}_2\text{O}]}$$

$$K_{eq} \times [\text{H}_2\text{O}] = K_b = \frac{[\text{NH}_4^+] \times [\text{OH}^-]}{[\text{NH}_3]}$$

In general, the **base dissociation constant ( $K_b$ )**

$$K_b = \frac{[\text{conjugate acid}] \times [\text{OH}^-]}{[\text{base}]}$$

The magnitude of  $K_b$  indicates the ability of a weak base to compete with the strong base  $\text{OH}^-$  for hydrogen ions.

The smaller the value of  $K_b$ , the weaker the base.

## Example

A 0.1000M solution of ethanoic acid is only partially ionized. From measurements of the pH of the solution,  $[H^+]$  is found to be  $1.34 \times 10^{-3}M$ . What is the  $K_a$  of ethanoic acid?

Try questions 22-29 on page 610-611