Acids and Bases Introduction

Strong Acids
Weak Acids
pH Curves
Buffer Theory
Buffer Calculations

Definitions

Firstly, you need to know what a Bronsted-Lowry acid or base is:

*acids **donate** protons (H^+) and bases **accept** protons*

Strong acids: an acid that **completely dissociates** (or ionises) in water

$$HCl \longrightarrow H^+ + Cl^-$$

Examples: Hydrochloric acid (HCl), Sulphuric acid (H_2SO_4), Nitric acid (HNO_3)

✓ **monobasic** (or monoprotic) refers to an acid that can only donate **one proton** e.g. HCl. A **dibasic** acid donates **two protons** e.g. H_2SO_4 and a **tribasic** donates **three protons** e.g. H_3PO_4.

Weak acids: incomplete dissociation in water

$$CH_3COOH \rightleftharpoons H^+ + CH_3COO^-$$

Examples: any carboxylic acid, they commonly use ethanoic acid (shown in the equation above).

✓ the main difference in the equations for strong and weak acids/bases is the equilibrium arrow for weak acids/bases compared with the normal reaction arrow for the strong acids/bases.

You can write similar equations to those above for bases.

Strong Bases: sodium hydroxide (NaOH) or another metal hydroxide is used almost exclusively:

$$NaOH \rightarrow Na^+ + OH^-$$

Weak bases: ammonia (NH_3) and sodium carbonate (Na_2CO_3)

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

✓ Note that water is required as a source of 'O' in this equation.

✓ The important point for bases is that you have OH^- ions in solution.

Conjugate Acid-Base

This is very easy. In conjugate pair questions you will see an equilibrium set up similarly to that shown below:

$$\boxed{HCOOH + CH_3COOH \rightleftharpoons HCOO^- + CH_3COOH_2^+}$$

There is an **acid and base** on the **left** side of the arrow and an **acid and base** on the **right** side of the arrow.

Your task is to identify which are the acids and which are the bases.

It might not be obvious at first in the example above, as there are two carboxylic acids on the left hand side BUT one of them is acting as a **base**! This means that one of the acids is stronger than the other.

All that happens in these reactions is the reactant acting as an acid **donates an H^+** to the other reactant….a simple **proton transfer**.

$$HCOOH + CH_3COOH \rightleftharpoons HCOO^- + CH_3COOH_2^+$$

H^+ transfer

The end result is that the HCOOH has lost an H^+ and The CH_3COOH has gained an H^+…very simple stuff.

The conjugate pairs

In the example above, the CH_3COOH and $CH_3COOH_2^+$ are a conjugate pair. This means that one of them is an acid and the other is a base. Similarly, HCOOH and $HCOO^-$ are a pair.

$\boxed{\mathbf{CH_3COOH/CH_3COOH_2^+}}$	$\boxed{\mathbf{HCOOH/HCOO}}$
conjugate pair 1	conjugate pair 2

✓ Always "pair up" the two molecules on opposite sides of the equation that "look" similar to each other. The only difference between them is one will have an extra 'H'.

But in each pair, how do you know which is the acid?

$\boxed{\text{the acid is the molecule of the pair with the \textbf{most} hydrogens}}$

Using this rule, we can say that **$CH_3COOH_2^+$ is the acid** and **CH_3COOH is the base.** And **HCOOH is the acid** and **$HCOO^-$ is the base**. Therefore we can also say that HCOOH is a stronger acid than CH_3COOH.

$CH_3COOH/CH_3COOH_2^+$

base **acid**

$HCOOH/HCOO^-$

acid **base**

In the example above the equation is given, but in some examples they may ask you to predict the products.

To do this, **you must know which is the stronger acid** out of the two compounds on the left hand side of the equation. This can be identified through the **K_a values** i.e. the larger the K_a value, the stronger the acid. In the example above, HCOOH must have a larger K_a value than CH_3COOH.

✓ K_a values are discussed in the weak acid tutorial.

Calculations introduction

Most of this topic is calculation based. I would recommend splitting the whole topic into 4 sections:

- strong acids/bases
- weak acids/bases
- pH curves
- buffer solutions

When beginning calculations, it is always a good idea to write down an equation (or anything else) that might help. The worst thing you can do is to sit staring at a blank page. Once you have something on the paper it can lead you towards the answer.

Please remember the old equation from GCSE and AS, you will need it....a lot:

number of moles = concentration x volume

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