OCR (B) Chemistry A-Level

O2 - Equilibria (Acid–Base)

Flashcards

What is a Brønsted-Lowry acid and base?

What is a Brønsted-Lowry acid and base?

- Brønsted-Lowry acid: proton donor.
- Brønsted-Lowry base: proton acceptor.

What is the proton donor and acceptor in this reaction:

$$HNO_{2(s)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + NO_2^-{}_{(aq)}$$

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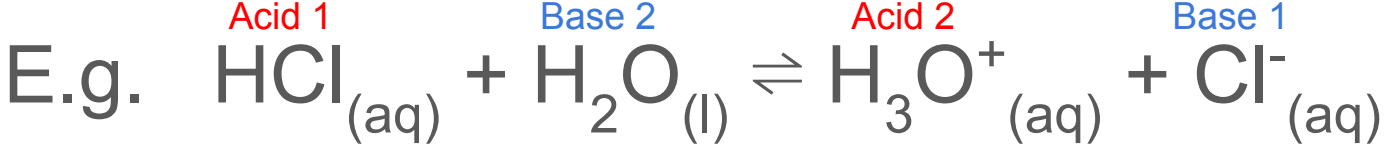
$$HNO_{2(s)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + NO_2^-{}_{(aq)}$$

- Proton donor: $HNO_{2(aq)}$
- Proton acceptor: $H_2O_{(l)}$

What is a conjugate acid-base pair?

What is a conjugate acid-base pair?

- A conjugate acid-base pair contains two species that can be easily converted by transferring a proton.

E.g. 

- **HCl and Cl^- are conjugate acid-base pairs.**
- **H_2O and H_3O^+ are conjugate acid-base pairs.**

What is a strong acid?

What is a strong acid?

A strong acid is an acid that completely dissociates in solution:

$$HCl_{(aq)} \rightleftharpoons H^+_{(aq)} + Cl^-_{(aq)}$$

What is a strong base?

What is a strong base?

A strong base is a base that completely dissociates in solution:

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

What is a weak acid?

What is a weak acid?

A weak acid is an acid that only partially dissociates in solution:

$$CH_3COOH_{(aq)} \rightleftharpoons CH_3COO^-_{(aq)} + H^+_{(aq)}$$

What is the acid dissociation constant?

What is the acid dissociation constant?

It measures, quantitatively, the strength of acid in solution.

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

What is pK_a?

What is pK_a?

$pK_a = -\log K_a$

pK_a values are much more manageable than K_a values and make it easier to compare the strengths of solutions.

What is pH?

What is pH?

- It is an easier way of measuring hydrogen ion concentration.
- There's a large range of $[H^+]$ values with negative powers of 10. The negative logarithm of $[H^+]$ gives a more manageable scale of 1 to 14 rather than 10^{-1} to 10^{-14}.

How can you measure the pH of a solution?

How can you measure the pH of a solution?

- With a pH probe.
- Using pH scales with a suitable indicator.

How do you calculate the pH of a strong acid?

How do you calculate the pH of a strong acid?

$HA \rightleftharpoons H^+ + A^-$

Strong acid: therefore the concentration of acid = concentration of H^+ ions.

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

How do you calculate the pH of a strong base?

How do you calculate the pH of a strong base?

$XOH \rightleftharpoons X^+ + OH^-$

- **Strong base**: therefore concentration of base = concentration of OH^- ions.
- $K_w = [H^+][OH^-]$ so $[H^+] = K_w/[OH^-]$
- $pH = -\log[H^+]$

How do you calculate the pH of a weak acid?

How do you calculate the pH of a weak acid?

$HA \rightleftharpoons H^+ + A^-$

Write K_a expression: $$K_a = \frac{[H^+][A^-]}{[HA]}$$

We can assume $[H^+] = [A^-]$ so: $$K_a = \frac{[H^+]^2}{[HA]}$$

Rearrange to make $[H^+]$ the subject: $$[H^+] = \sqrt{K_a \times [HA]}$$

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

What is a buffer?

What is a buffer?

A system that minimises pH changes on addition of small amounts of an acid or base.

How do buffers work?

How do buffers work?

E.g. $CH_3COOH_{(aq)} \rightleftharpoons CH_3COO^-_{(aq)} + H^+_{(aq)}$

- Upon addition of **acid:** More H^+ ions are present in the solution and so combine with $CH_3COO^-_{(aq)}$ to form CH_3COOH. The **reverse** reaction is favoured and the position of equilibrium shifts to the **left.**
- Upon addition of **base:** More OH^- ions are present in the solution and so combine with H^+ to form H_2O. The **forward** reaction is favoured and the position of equilibrium shifts to the **right.**

What is a weak acid buffer?

What is a weak acid buffer?

A mixture of a weak acid and its conjugate base (usually in the form of one of its salts i.e. $CH_3COO^-Na^+$).

How do you calculate the pH of a weak acid buffer solution?

How do you calculate the pH of a weak acid buffer solution?

E.g. $CH_3COOH_{(aq)} \rightleftharpoons CH_3COO^-_{(aq)} + H^+_{(aq)}$

- Write K_a expression: $K_a = \frac{[H^+][CH_3COO^-]}{[CH_3COOH]}$
- Make $[H^+]$ the subject: $[H^+] = \frac{K_a \times [CH_3COOH]}{[CH_3COO^-]}$
- Calculate $[H^+]$ and then substitute into $pH = -\log[H^+]$

What assumptions are made in this weak acid buffer calculation?

What assumptions are made in this weak acid buffer calculation?

- [Salt] = $[A^-]$
- [Acid] = [HA] as only slightly dissociated

How do you calculate the pH of a buffer solution made by partial neutralisation?

How do you calculate the pH of a buffer solution made by partial neutralisation?

E.g. $HCOOH_{(aq)} + NaOH_{(aq)} \rightarrow HCOO^-Na^+_{(aq)} + H_2O_{(l)}$

- Here, the acid is in excess so not all acid is converted into the salt, leaving some leftover. All NaOH reacts however.
- Calculate the number of moles of each compound reacted and at equilibrium and hence their concentrations.
- Substitute into the K_a expression and rearrange for $[H^+]$.
- $pH = -\log[H^+]$