

Properties of acids and bases

TYPICAL PROPERTIES OF ACIDS AND BASES

A simple definition of an acid is that it is a substance that produces H^+ ions in aqueous solution. A base is a substance that can neutralize an acid. An alkali is a base that is soluble in water.

The typical reactions of acids are:

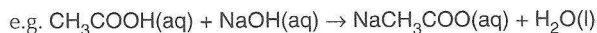
1. With indicators.

Acid-base indicators can be used to determine whether or not a solution is acidic. Common indicators include:

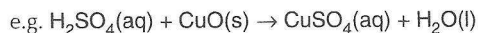
Indicator	Colour in acidic solution	Colour in alkaline solution
litmus	red	blue
phenolphthalein	colourless	pink
methyl orange	red	yellow

2. Neutralization reactions with bases.

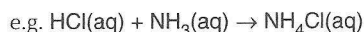
(a) With hydroxides to form a salt and water,



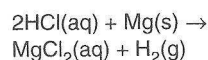
(b) With metal oxides to form a salt and water,



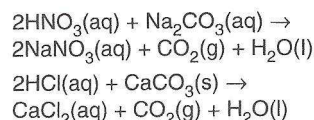
(c) With ammonia to form a salt.



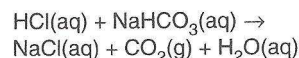
3. With reactive metals (those above copper in the reactivity series) to form a salt and hydrogen, e.g.



4. With carbonates (soluble or insoluble) to form a salt, carbon dioxide, and water, e.g.



5. With hydrogencarbonates to form a salt, carbon dioxide, and water, e.g.



STRONG AND WEAK ACIDS AND BASES

A strong acid is completely dissociated (ionized) into its ions in aqueous solution. Similarly a strong base is completely dissociated into its ions in aqueous solution. Examples of strong acids and bases include:

Strong acids

hydrochloric acid, HCl
nitric acid, HNO_3
sulfuric acid, H_2SO_4

Strong bases

sodium hydroxide, NaOH
potassium hydroxide, KOH
barium hydroxide, $\text{Ba}(\text{OH})_2$

Note: because one mole of HCl produces one mole of hydrogen ions it is known as a **monoprotic** acid. Sulfuric acid is known as a **diprotic** acid as one mole of sulfuric acid produces two moles of hydrogen ions.

Weak acids and bases are only slightly dissociated (ionized) into their ions in aqueous solution.

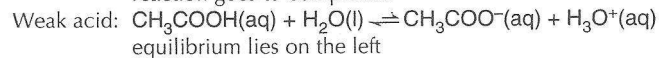
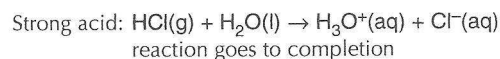
Weak acids

ethanoic acid, CH_3COOH
'carbonic acid' (CO_2 in water), H_2CO_3

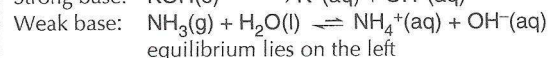
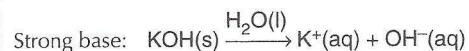
Weak bases

ammonia, NH_3
aminoethane, $\text{C}_2\text{H}_5\text{NH}_2$

The difference can be seen in their reactions with water:



i.e. a solution of hydrochloric acid consists only of hydrogen ions and chloride ions in water, whereas a solution of ethanoic acid contains mainly undissociated ethanoic acid with only very few hydrogen and ethanoate ions.

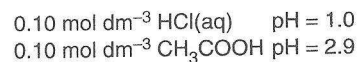


Note: in aqueous solution a hydrogen ion reacts with a water molecule to form the hydronium ion $\text{H}_3\text{O}^+(\text{aq})$. In IB chemistry both $\text{H}^+(\text{aq})$ and $\text{H}_3\text{O}^+(\text{aq})$ are acceptable to represent a hydrogen ion in aqueous solution.

EXPERIMENTS TO DISTINGUISH BETWEEN STRONG AND WEAK ACIDS AND BASES

1. pH measurement

Because a strong acid produces a higher concentration of hydrogen ions in solution than a weak acid, with the same concentration, the pH of a strong acid will be lower than a weak acid. Similarly a strong base will have a higher pH in solution than a weak base, with the same concentration. The most accurate way to determine the pH of a solution is to use a pH meter.



2. Conductivity measurement

Strong acids and strong bases in solution will give much higher readings on a conductivity meter than **equimolar** (equal concentration) solutions of weak acids or bases, because they contain more ions in solution.