**Conjugate Acid-Base Pairs**

An acid-base reaction according to the Brønsted-Lowry definition is a transfer of a [proton](https://www.ck12.org/c/physical-science/proton?referrer=crossref) from one molecule or [ion](https://www.ck12.org/c/physical-science/ion?referrer=crossref) to another. When ammonia is dissolved in [water](https://www.ck12.org/c/biology/water?referrer=crossref), it undergoes the following [reversible reaction](https://www.ck12.org/c/chemistry/reversible-reaction?referrer=crossref).

 NH3(aq) + H2O(l) ⇄ NH+4(aq) + OH−(aq)

 base    acid acid   base

According to the brønsted-lowry definitions in this reaction, ammonia is acting as a base by accepting a proton from water, and conversely, the [water](https://www.ck12.org/c/biology/water?referrer=crossref) molecule is acting as an acid by donating a [proton](https://www.ck12.org/c/physical-science/proton?referrer=crossref) to the ammonia molecule. The resulting products are the ammonium [ion](https://www.ck12.org/c/physical-science/ion?referrer=crossref) and the hydroxide ion. The water is acting as a Brønsted-Lowry [acid](https://www.ck12.org/c/physical-science/acid?referrer=crossref), while the ammonia is acting as a Brønsted-Lowry base. The hydroxide ion that is produced causes the resulting [solution](https://www.ck12.org/c/physical-science/solution?referrer=crossref) to be basic.

We can also consider the reverse reaction in the above equation.

 NH+4(aq) + OH−(aq) ⇄ NH3(aq) + H2O(l)

In this reaction, the ammonium [ion](https://www.ck12.org/c/physical-science/ion?referrer=crossref) donates a [proton](https://www.ck12.org/c/physical-science/proton?referrer=crossref) to the hydroxide ion. The ammonium ion is a Brønsted-Lowry [acid](https://www.ck12.org/c/physical-science/acid?referrer=crossref), while the hydroxide ion is a Brønsted-Lowry base. Most [Brønsted-Lowry acid-base reactions](https://www.ck12.org/c/chemistry/br%C3%B8nsted-lowry-acid-base-reactions?referrer=crossref" \o "Brønsted-Lowry acid-base reactions) can be analyzed in this way. There is one acid and one base as reactants, and one acid and one base as products.

In the above reaction, [water](https://www.ck12.org/c/biology/water?referrer=crossref) acted as an acid, which may seem a bit unexpected. Water can also act as a base in a Brønsted-Lowry acid-base reaction, as long as it reacts with a substance that is a better proton donor. Shown below is the reaction of water with the hydrogen sulphate ion (sulphuric acid donating it’s second proton).

 HSO4−(aq) + H2O(l) ⇄ H3O+(aq) + SO42−(aq)

 acid   base   acid   base

So, water is capable of being either an acid or a base, a characteristic called amphoterism. An **amphoteric substance** is one that is capable of acting as either an acid or a base by donating or accepting hydrogen ions.

**Conjugate**[**Acids and Bases**](https://www.ck12.org/c/biology/acids-and-bases?referrer=crossref)

When a substance that is acting as a Brønsted-Lowry acid donates its proton, it becomes a base in the reverse reaction. In the reaction above, the hydrogen sulphate ion (HSO4−) donates a proton to water and becomes a sulphate ion (SO42−). The HSO4− and the SO42− are linked to one another by the presence or absence of the H+ ion. A **conjugate acid-base pair** is a pair of substances related by the loss or gain of a single hydrogen ion. A **conjugate acid** is the particle produced when a base accepts a proton. The hydrogen sulphate ion is the conjugate acid of the sulphate ion. A **conjugate base** is the particle produced when an acid donates a proton. The sulphate ion is the conjugate base of the hydrogen sulphate ion.

In the reaction illustrated below, water serves both as acid and base simultaneously. One water molecule serves as an acid and donates a proton. The other water molecule functions as a base by accepting the proton.

A typical Brønsted-Lowry acid-base reaction contains two conjugate acid-base pairs as shown below.

 HNO2(aq) + PO43−(aq) ⇄ NO2− (aq) + HPO42−(aq)

One conjugate acid-base pair is HNO2 / NO2−, while the other pair (base/acid) is HPO42− / PO43−.

QUESTIONS

1. Fill in the blanks

| Acid | **Conjugate Base** |
| --- | --- |
| ***Strong Acids*** |   |
| HCl (hydrochloric acid) |   |
|   | HSO4- (hydrogen sulfate ion) |
|   | NO3- (nitrate ion) |
| ***Weak Acids*** |   |
| H3PO4 (phosphoric acid) |   |
|   | CH3COO- (acetate ion) |
|   | HCO3- (hydrogen carbonate ion) |
| HCN (hydrocyanic acid) |   |