

What Are Acids and Bases?

What is the difference between an acid and a base?

●○○ Beginner

Acids & Bases

Last reviewed 3 October 2026

What is it?

Acids and bases are two important families of substances, and they react with each other. Two definitions are used at this level:

	Acid	Base
Arrhenius (in water)	Produces H^+ ions (more precisely H_3O^+) when dissolved in water	Produces OH^- ions when dissolved in water
Brønsted–Lowry (more general)	Donates a proton (H^+)	Accepts a proton (H^+)

A hydrogen ion, H^+ , is just a proton: a hydrogen atom that has lost its only electron.

KEY IDEA

In the Brønsted–Lowry picture, an acid–base reaction is a **proton transfer**: the acid gives an H^+ and the base takes it.

Why does it matter?

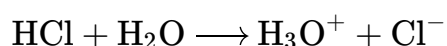
Acids and bases are everywhere:

- **In your body:** stomach acid contains hydrochloric acid, HCl , which helps digest food, and the pH of blood is kept within a narrow range.
- **At home:** vinegar contains acetic acid; baking soda (sodium hydrogen carbonate) and many cleaning products are basic; antacid tablets neutralize excess stomach acid.
- **In the environment and industry:** soil acidity affects which crops grow; acid–base reactions are used to make fertilisers, medicines and many other products.

How does it work?

1. Acids donate protons

When hydrogen chloride dissolves in water, it gives a proton to a water molecule:

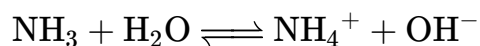


HCl is the acid (proton donor) and water is the base (proton acceptor). The ion H_3O^+ is called the **hydronium ion**.

2. Bases accept protons

Some bases contain hydroxide ions, such as sodium hydroxide: $\text{NaOH} \longrightarrow \text{Na}^+ + \text{OH}^-$. The OH^- ion accepts protons.

Other bases contain no OH^- at all. Ammonia accepts a proton from water and *produces* OH^- :



3. Conjugate acid–base pairs

When an acid gives away a proton, what is left can take a proton back, so it is a base: its **conjugate base**. When a base accepts a proton it becomes its **conjugate acid**. The two members of a **conjugate pair** differ by exactly one H^+ :

- HCl / Cl^-
- $\text{H}_3\text{O}^+ / \text{H}_2\text{O}$
- $\text{NH}_4^+ / \text{NH}_3$

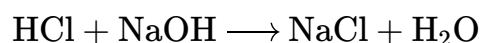
4. Strong and weak acids and bases

- A **strong acid** ionizes **completely** in water: essentially every molecule gives up its proton. Examples: HCl , HNO_3 , H_2SO_4 (its first proton).
- A **weak acid** ionizes only **partly**: most molecules stay intact. Example: acetic acid, CH_3COOH .
- **Strong bases** include the hydroxides of Group 1 metals, such as NaOH and KOH . **Weak bases** include ammonia, NH_3 .

A double arrow ($\rightleftharpoons$) shows a reaction that goes only partly; a single arrow ($\longrightarrow$) shows one that goes essentially to completion.

5. Neutralization

An acid and a base react to form a **salt** and **water**:



The essential change is that H^+ and OH^- combine to make water: $\text{H}^+ + \text{OH}^- \longrightarrow \text{H}_2\text{O}$.

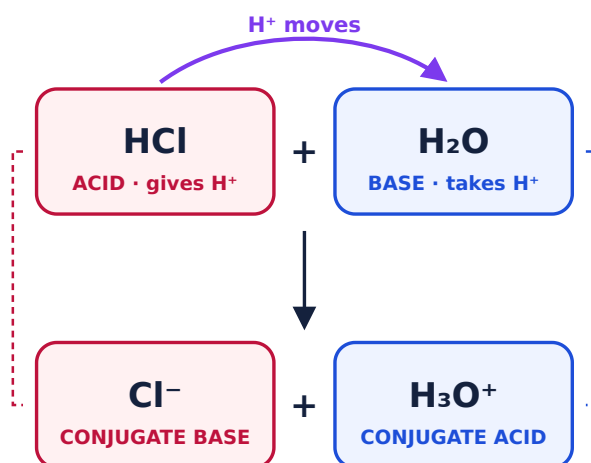
∞ THINK OF IT LIKE THIS

Think of the proton as a ball. The acid **throws** the ball and the base **catches** it. After the throw, the thrower is empty-handed but could catch a ball back (the conjugate base), and the catcher now holds a ball it could throw again (the conjugate acid).

🔍 MORE PRECISELY

A bare H^+ ion doesn't float freely in water: it is always attached to water molecules. Writing H^+ (aq) is a convenient shorthand for H_3O^+ (aq). There is also a broader definition, the **Lewis** definition, in which an acid accepts a pair of electrons and a base donates one. It covers reactions with no proton transfer at all.

Visualise it



Dashed lines join each conjugate pair:
HCl / Cl⁻ and H₃O⁺ / H₂O differ by one H⁺.

Colour is a guide only; labels show each role.

An acid–base reaction is a proton (H⁺) transfer.

Worked example

WORKED EXAMPLE: Identifying acid, base and conjugate pairs

Question: In the reaction $\text{NH}_3 + \text{H}_2\text{O} \rightleftharpoons \text{NH}_4^+ + \text{OH}^-$, identify the acid, the base and the two conjugate pairs.

Step 1 Water loses a proton (it becomes OH^-), so **water is the acid**.

Step 2 Ammonia gains a proton (it becomes NH_4^+), so **ammonia is the base**.

Step 3 Conjugate pairs differ by one H^+ : $\text{NH}_4^+ / \text{NH}_3$ and $\text{H}_2\text{O} / \text{OH}^-$.

Note: in the HCl reaction, water acted as a **base**; here it acts as an **acid**. Substances that can do both are called **amphoteric**.

WORKED EXAMPLE: Writing a neutralization equation

Question: Write the equation for the neutralization of nitric acid, HNO_3 , by potassium hydroxide, KOH .

Step 1 Acid + base $\rightarrow$ salt + water.

Step 2 The salt combines the metal ion from the base (K^+) with the anion from the acid (NO_3^-): KNO_3 .

Answer: $\text{HNO}_3 + \text{KOH} \rightarrow \text{KNO}_3 + \text{H}_2\text{O}$

Common mistake

COMMON MISTAKE: Confusing 'strong' with 'concentrated'

Strong describes how completely an acid ionizes. **Concentrated** describes how much acid is dissolved in a given volume. A dilute solution of a strong acid (HCl) and a concentrated solution of a weak acid (acetic acid) are both possible.

COMMON MISTAKE: Thinking every base contains OH^-

Ammonia, NH_3 , has no hydroxide ion, but it is a base because it **accepts a proton**. The Brønsted-Lowry definition covers it; the Arrhenius definition, strictly applied, does not.

COMMON MISTAKE: Mixing up conjugate pairs

A conjugate pair differs by **exactly one** H^+ . H_3O^+ and OH^- are **not** a conjugate pair: they differ by two protons.

NOTATION NOTE

- H^+ (aq) and H_3O^+ (aq) are both used for the hydrated proton; many textbooks switch between them.
- “Ionize” and “dissociate” are often used interchangeably for acids in water.
- Some courses spell the term *neutralisation* (British spelling).

Remember this

REMEMBER THIS

- Acid = proton (H^+) **donor**; base = proton (H^+) **acceptor**.
- Conjugate pairs differ by exactly one H^+ .
- Strong = ionizes completely; weak = ionizes partly. Strong $\neq$ concentrated.
- Acid + base $\rightarrow$ salt + water.

References

1. Brown, T. L.; LeMay, H. E., Jr.; Bursten, B. E.; Murphy, C. J.; Woodward, P. M.; Stoltzfus, M. W. Chemistry: The Central Science, 15th ed.; Pearson, 2022.

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