

Proton transfer reactions

Reactivity 3.1 · SL

What do vinegar and cleaning ammonia share?

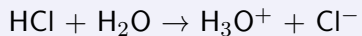
Every acid–base reaction is a proton transfer.

- Vinegar turns blue litmus red; ammonia turns red litmus blue.
- In both, a proton moves from one particle to another.
- This unit: acids and bases $\rightarrow$ pH $\rightarrow$ strength $\rightarrow$ titrations.

Donors and acceptors

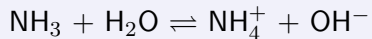
Brønsted–Lowry acid

Proton donor.



Brønsted–Lowry base

Proton acceptor.



Conjugate pairs differ by one proton

Acid	Conjugate base
HCl	Cl^-
H_3O^+	H_2O
H_2O	OH^-
NH_4^+	NH_3

The pH scale

- One pH unit lower means ten times more H^+ .
- Decimal places in pH match significant figures in $[\text{H}^+]$.

$$\text{pH} = -\log_{10}[\text{H}^+] \quad [\text{H}^+] = 10^{-\text{pH}}$$

0.050 mol dm⁻³ HCl: pH = 1.30.

The ionic product of water

- 1 **Constant.** $K_w = [\text{H}^+][\text{OH}^-] = 1.00 \times 10^{-14}$ at 298 K
- 2 **Alkali.** 0.010 mol dm⁻³ NaOH: $[\text{OH}^-] = 0.010$
- 3 **Divide.** $[\text{H}^+] = 1.0 \times 10^{-12}$

Decision

pH = 12.00

Strong against weak

0.10 mol dm⁻³	HCl (strong)	CH₃COOH (weak)
pH	1.0	about 2.9
conductivity	high	low
rate with Mg	fast	slow

Use the evidence

Total gas volume and alkali needed are the same for both.

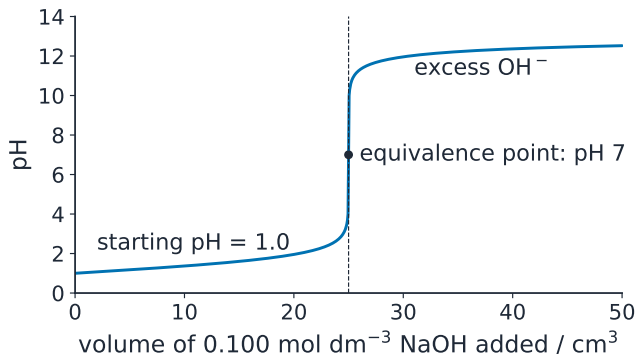
Check: strength or concentration?

Your turn

Which statement about 0.10 mol dm^{-3} ethanoic acid is correct?

- A. It is a strong, dilute acid.
- B. It is a weak acid with a higher pH than 0.10 mol dm^{-3} HCl.
- C. It needs less NaOH to neutralize than the same HCl solution.
- D. It contains more H^+ ions than the same HCl solution.

The strong acid–strong base pH curve



For **strong acid** with strong base the **equivalence point** is pH 7.

Exam tips

Never use "strong" to mean "concentrated".

- Acids donate, bases accept; a base needs a lone pair.
- Conjugate pairs differ by exactly one H^+ .
- Neutral means $[\text{H}^+] = [\text{OH}^-]$.

Check yourself

Try these

Show that HCO_3^- is amphoteric with two equations.

Calculate the pH of $0.0025 \text{ mol dm}^{-3}$ HCl and $0.050 \text{ mol dm}^{-3}$ KOH.

Describe two tests that tell a strong acid from a weak acid.