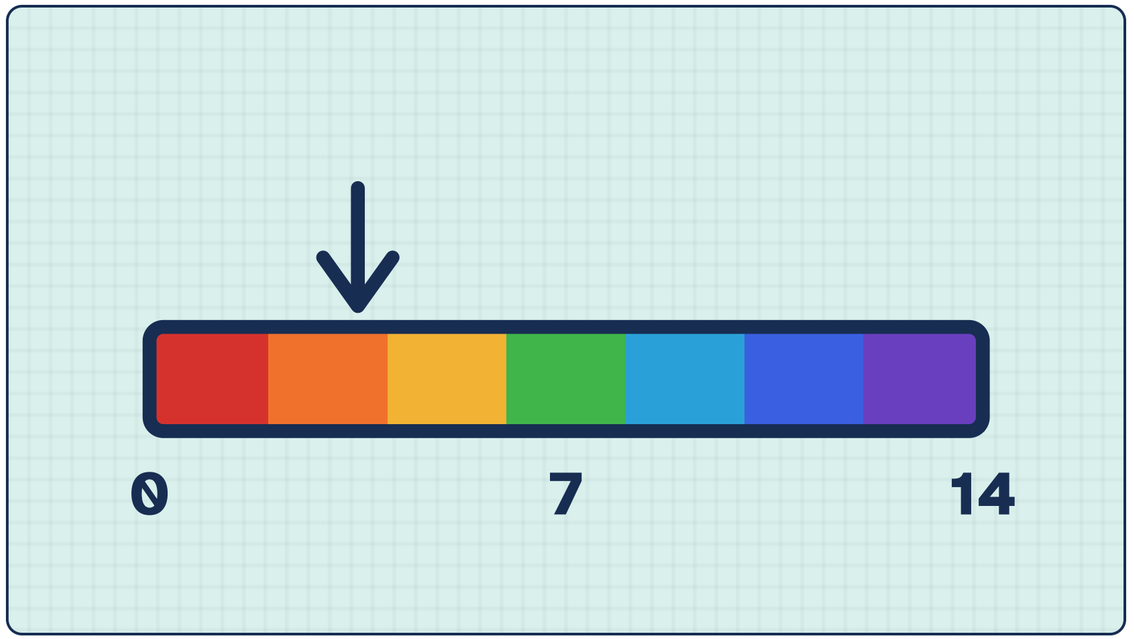
Chemistry · Measuring how acidic or alkaline a solution is

Acids, Bases and the pH Scale



Goals

By the end of this lesson you can

- Describe acids and alkalis with everyday examples
- Tell a base apart from an alkali
- Use the pH scale and indicators
- Explain the tenfold steps of the pH scale
- Describe neutralisation and name the salt

Acids and alkalis are everywhere

- Lemon and lime juice contain citric acid
- Vinegar contains ethanoic (acetic) acid
- Your stomach makes hydrochloric acid to help digest food
- Many household cleaners are alkaline
- Indigestion tablets contain bases that cancel out stomach acid

Acids and alkalis compared

Acids

- pH less than 7
- Turn blue litmus paper red
- Edible ones taste sour (never taste in the lab)
- React with many metals to give hydrogen gas
- Concentrated acids are corrosive

Alkalis

- pH more than 7
- Turn red litmus paper blue
- Are bases that dissolve in water
- Neutralise acids
- Concentrated alkalis are corrosive too

Base or alkali?

- A base is any substance that reacts with an acid to make a salt and water
- An alkali is a base that dissolves in water
- So every alkali is a base, but not every base is an alkali
- Sodium hydroxide is a base and an alkali
- Copper oxide is a base but does not dissolve, so it is not an alkali

The pH scale

- A number scale, usually shown from 0 to 14
- pH 7 is neutral, like pure water
- Below 7 is acidic: the lower the number, the more acidic
- Above 7 is alkaline: the higher the number, the more alkaline
- pH measures the concentration of hydrogen ions in a solution

Each step on the pH scale is ten times

×10

A solution at pH 3 has ten times the hydrogen ion concentration of one at pH 4

Everyday substances on the pH scale

From strong acid at pH 0 to strong alkali at pH 14, with pure water neutral at pH 7.



Poster: The pH Scale: Acids, Alkalis and Neutral

Indicators show acid or alkali

- An indicator changes colour depending on pH
- Litmus: red in acid, blue in alkali
- Universal indicator: red (strong acid), green (neutral), purple (strong alkali)
- Red cabbage juice is a natural indicator
- A pH meter gives a more precise number

Litmus or universal indicator?

Litmus

- Only two colours: red or blue
- Tells you acid or alkali
- Does not tell you how acidic
- Neutral: neither paper changes colour

Universal indicator

- A range of colours across the pH scale
- Gives an approximate pH number
- Shows strongly or weakly acidic or alkaline
- Compare the colour with a chart

Worked example

Worked example: comparing two solutions

- Lemon juice: about pH 2. Coffee: about pH 5
- Difference: 5 – 2 = 3 steps
- Each step is ×10, so 10 × 10 × 10
- Lemon juice is about 1,000 times more acidic
- Coffee is still acidic, just much less so

Neutralisation

- Acid + base → salt + water
- Hydrogen ions from the acid react with hydroxide ions: $H^+ + OH^- \rightarrow H_2O$
- The pH moves towards 7
- Universal indicator changes towards green
- Too much alkali makes the mixture alkaline again

Worked example

Naming the salt

- Hydrochloric acid + sodium hydroxide → sodium chloride + water
- First part of the name comes from the base (sodium)
- Second part comes from the acid (chloride)
- Hydrochloric gives chlorides; sulfuric gives sulfates; nitric gives nitrates
- Antacid: magnesium hydroxide + hydrochloric acid → magnesium chloride + water

Working safely with acids and alkalis

- Wear eye protection throughout
- Use dilute solutions in small volumes
- Never taste or smell chemicals to identify them
- Rinse spills on skin with plenty of cold water and tell the teacher
- Alkalis are especially harmful to eyes

Quick check

A solution turns universal indicator purple. What is its approximate pH?

A. pH 1

B. pH 7

C. pH 5

D. pH 13

Summary

Key takeaways

1. Acids have pH below 7; alkalis have pH above 7; pH 7 is neutral
2. An alkali is a base that dissolves in water
3. Each pH step is a tenfold change
4. Litmus shows acid or alkali; universal indicator shows the approximate pH
5. Acid + base → salt + water