

The pH scale and neutralisation

4.4.2.4 · Chemical changes · revision notes

What pH tells you, how to measure it with universal indicator or a pH probe, and which ions make solutions acidic or alkaline. Neutralisation between an acid and an alkali is summed up by the ionic equation $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$.

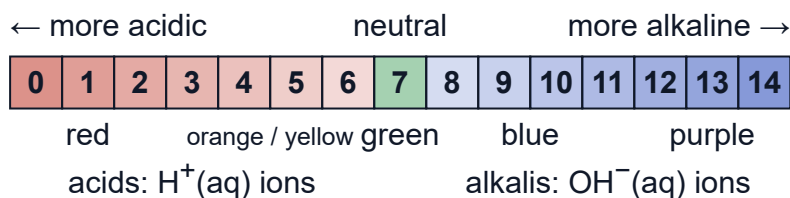
Key facts

- pH below 7 = acidic; pH 7 = neutral; pH above 7 = alkaline
- Alkalis produce $\text{OH}^-(\text{aq})$ ions
- Universal indicator: red $\rightarrow$ orange $\rightarrow$ yellow $\rightarrow$ green (pH 7) $\rightarrow$ blue $\rightarrow$ purple
- Acids produce $\text{H}^+(\text{aq})$ ions
- $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$
- pH probe: numerical reading, more precise than indicator

Notes

The pH scale

- The pH scale runs from **0 to 14**. It measures how acidic or alkaline a solution is.
- pH 7 is **neutral**, e.g. pure water. Acids have a pH **below 7**. Alkalis have a pH **above 7**.
- The lower the pH, the more acidic the solution. The higher the pH, the more alkaline.



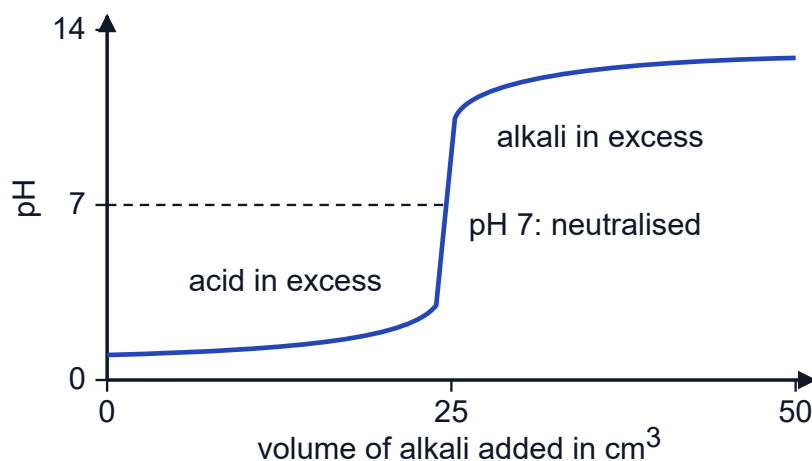
The words under the scale are the universal indicator colours.

Measuring pH

- Universal indicator** is a wide range indicator: its colour changes across the whole pH scale.
- Colours: red (strongly acidic), orange and yellow (weakly acidic), green (neutral), blue (weakly alkaline), purple (strongly alkaline).
- Add a few drops to the solution, or dip universal indicator paper into it, and match the colour to a pH chart. This gives an approximate pH, as a whole number.
- A **pH probe** (pH meter) gives a numerical reading, usually to one or two decimal places. It is more precise and does not depend on judging a colour.

Ions and neutralisation

- Acids produce **hydrogen ions, H^+** , in aqueous solution.
- Alkalis produce **hydroxide ions, OH^-** , in aqueous solution.
- When an acid reacts with an alkali, hydrogen ions react with hydroxide ions to make water: $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$.
- The other ions, e.g. Na^+ and Cl^- , stay in the solution and make up the salt.
- Adding alkali to an acid makes the pH rise: it is 7 when the acid is exactly neutralised and goes above 7 if more alkali is added.



Adding alkali to acid: the pH rises slowly, then jumps through 7 when the acid is just neutralised.

How to answer each type of question

Use pH values to identify solutions

1 mark each

Grade 3

1. Below 7 is acidic, 7 is neutral, above 7 is alkaline.
2. The further from 7, the more strongly acidic or alkaline.

Example. The pH values of four solutions are shown.

Solution	A	B	C	D
pH	1	7	9	13

- (a) Which solution is neutral?
- (b) Which solution is the most strongly alkaline?
- (c) What colour would universal indicator turn in solution A?

Model answer. (a) B (1)

(b) D (1)

(c) Red (1)

Describe how to measure pH

2 marks

Grade 4

1. Say what you use: universal indicator (solution or paper) or a pH probe.
2. Say how you read the result: compare with a colour chart, or read the meter.

Example. Describe how a student could use universal indicator to find the pH of a sample of rainwater.

Model answer. Add a few drops of universal indicator to a sample of the rainwater (1)
Match the colour to a pH colour chart to find the pH (1)

Give advantages of a pH probe

2 marks

Grade 5

1. A probe gives a number, often to decimal places, so it is more precise.
2. It does not rely on someone judging a colour.

Example. Give two advantages of using a pH probe rather than universal indicator to measure the pH of a solution.

Model answer. Gives a more precise value / reads to decimal places (1)
Does not depend on judging a colour / not affected by the colour of the solution (1)

Don't lose marks

- ✗ Saying alkalis have a pH below 7, or that pH 7 is weakly acidic.
- ✗ Mixing up the ions: acids produce H^+ , alkalis produce OH^- .
- ✗ Writing the ionic equation with H_2 or O^{2-} instead of H^+ and OH^- .
- ✗ Leaving out state symbols when the question asks for them: (aq), (aq), (l).

More tips

Memory tricks

- Think of the pH scale as a number line: acids at the low end, alkalis at the high end, neutral in the middle at 7.
- Universal indicator colours run roughly like a rainbow: red for strong acid through green for neutral to purple for strong alkali.
- Neutralisation always makes water: $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$.

Exam technique

- Link pH to ions: a lower pH means a higher concentration of H^+ ions.
- When describing a pH change, give the direction and the values, e.g. 'rises from 1 to 7, then above 7'.
- Learn the universal indicator colours for strong acid, neutral and strong alkali: red, green, purple.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

Use pH to classify solutions

Below 7 is acidic, 7 is neutral and above 7 is alkaline.

Grade 4

Measure pH with universal indicator

Add the indicator and match its colour to a pH colour chart.

Grade 5

Name the ions in acids and alkalis

Acids produce H^+ ions in water and alkalis produce OH^- ions in water.

Grade 5

Compare universal indicator with a pH probe

A pH probe gives a more precise numerical reading; universal indicator gives an approximate value from a colour.

Grade 5

Describe the pH change during neutralisation

As alkali is added to acid, the pH rises to 7 at neutralisation and above 7 when alkali is in excess.

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