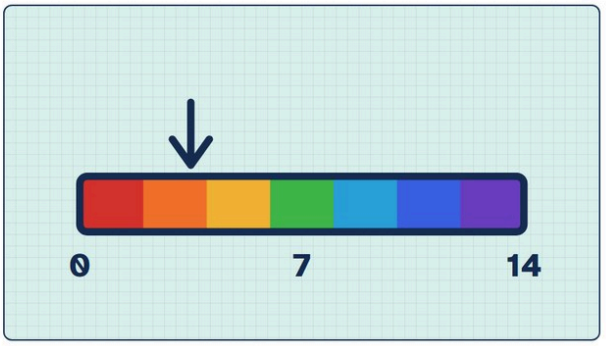
Chemistry · Measuring how acidic or alkaline a solution is

Acids, Bases and the pH Scale



Acids, Bases and the pH Scale

Teacher notes

Hold up a lemon, a bottle of vinegar and a packet of indigestion tablets. Ask: what could these three things have in common? Accept guesses, then tell students that two are acids and one is a base, and by the end of the lesson they will be able to say which is which and why the tablets work.

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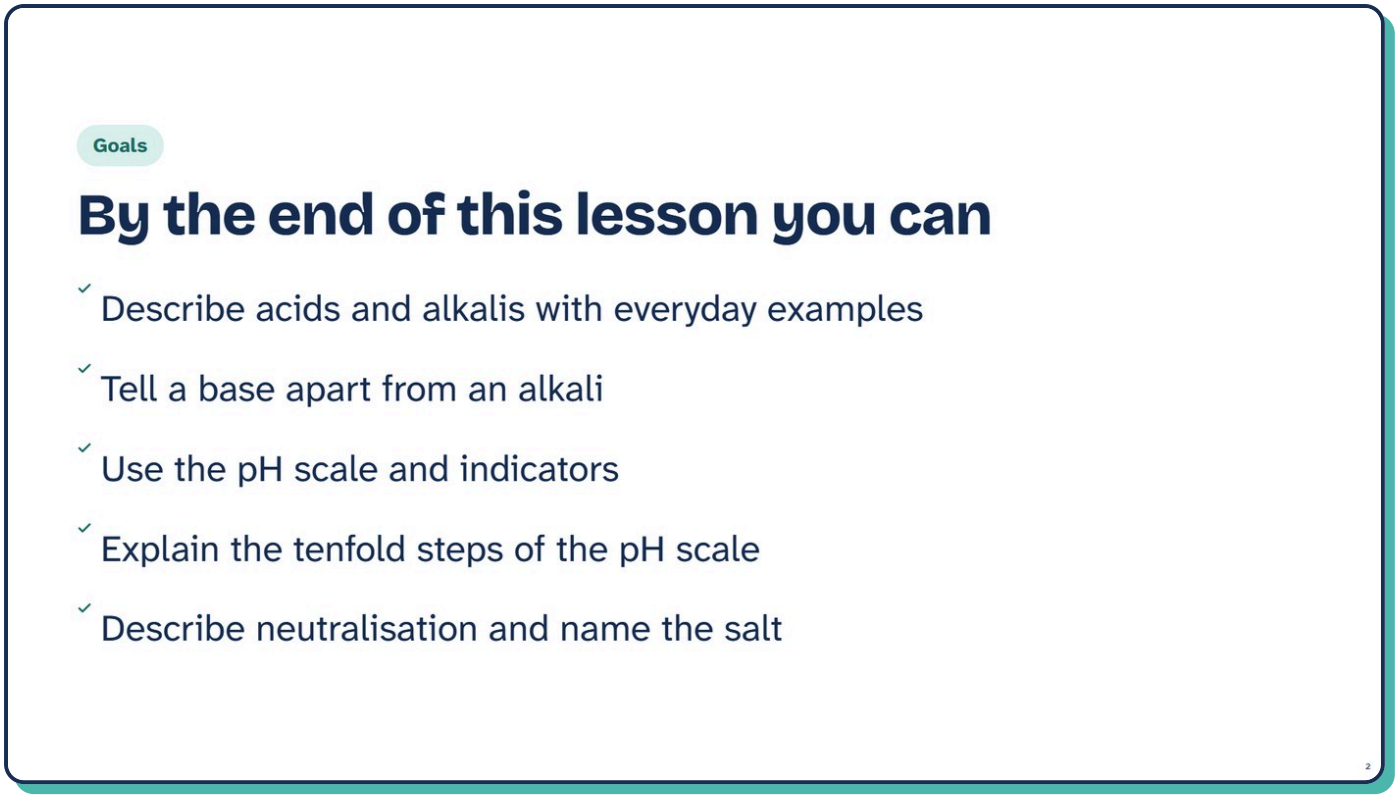

By the end of this lesson you can

Teacher notes

Tell students there is a short practical in the middle of the lesson, so eye protection will be needed. Ask what they already know about the word 'acid'; many will associate it only with danger, which this lesson will broaden.

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Acids and alkalis are everywhere

Teacher notes

Edible acids taste sour, but in the laboratory you must never taste anything to test it. Ask students to sort a list of kitchen and bathroom items into 'probably acid' and 'probably alkali'; keep the list to test later with indicator.

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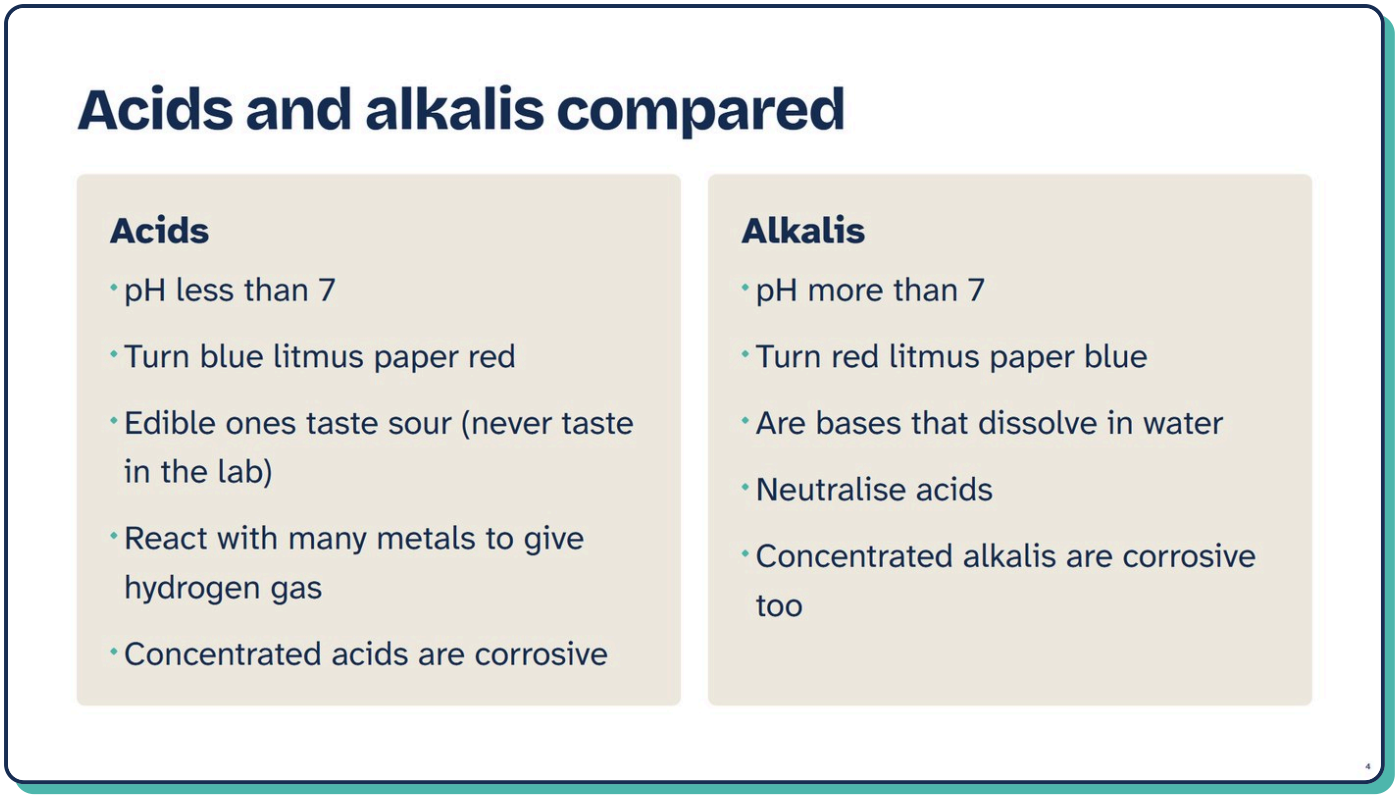

Acids and alkalis compared

Teacher notes

Point out the symmetry: acids and alkalis are opposites that cancel each other out. A common misconception is that only acids are dangerous; concentrated alkalis such as oven cleaner and drain cleaner can cause serious burns, especially to the eyes.

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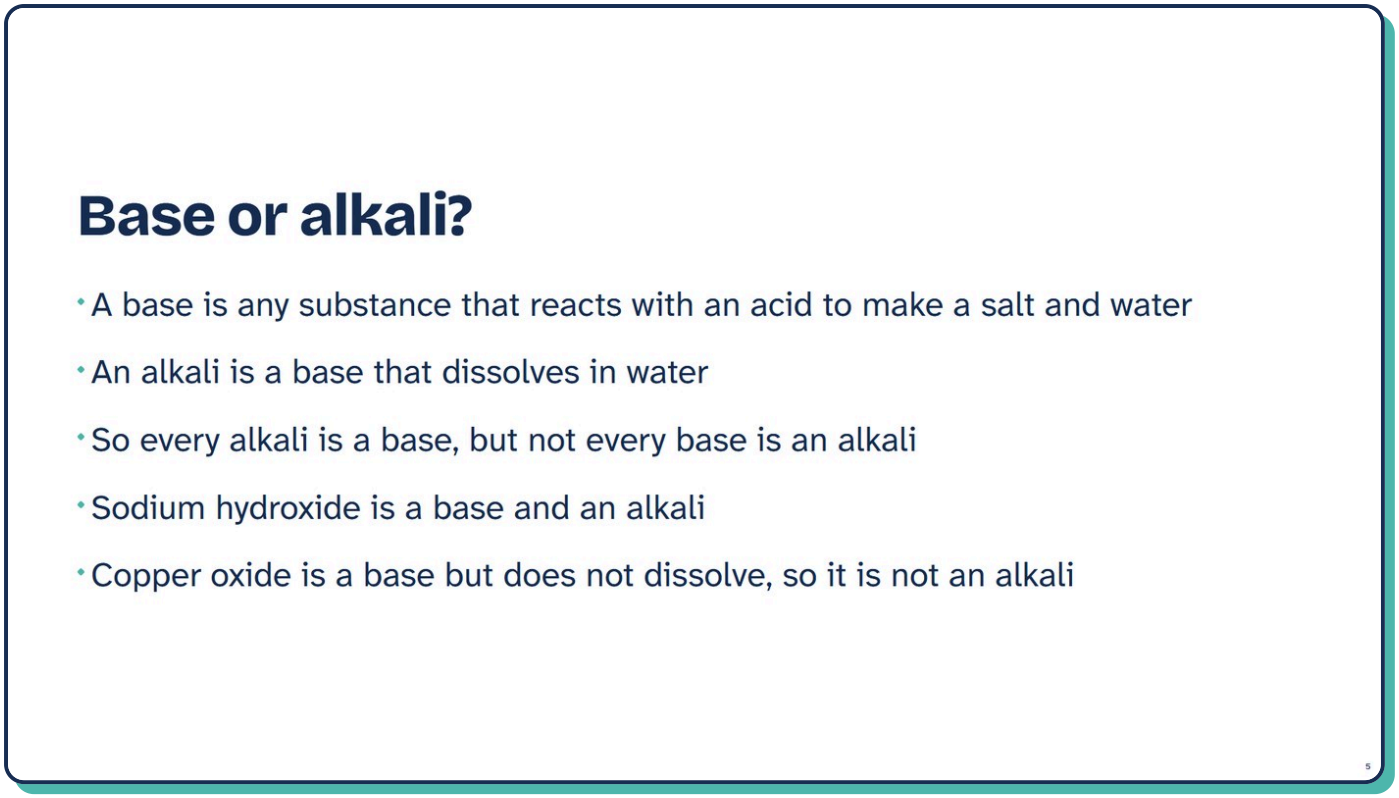

Base or alkali?

Teacher notes

Draw a big circle labelled 'bases' with a smaller circle inside labelled 'alkalis'. Ask students where magnesium hydroxide in an antacid suspension would go: it is a base that is only slightly soluble, which is why it is sold as a cloudy 'milk'.

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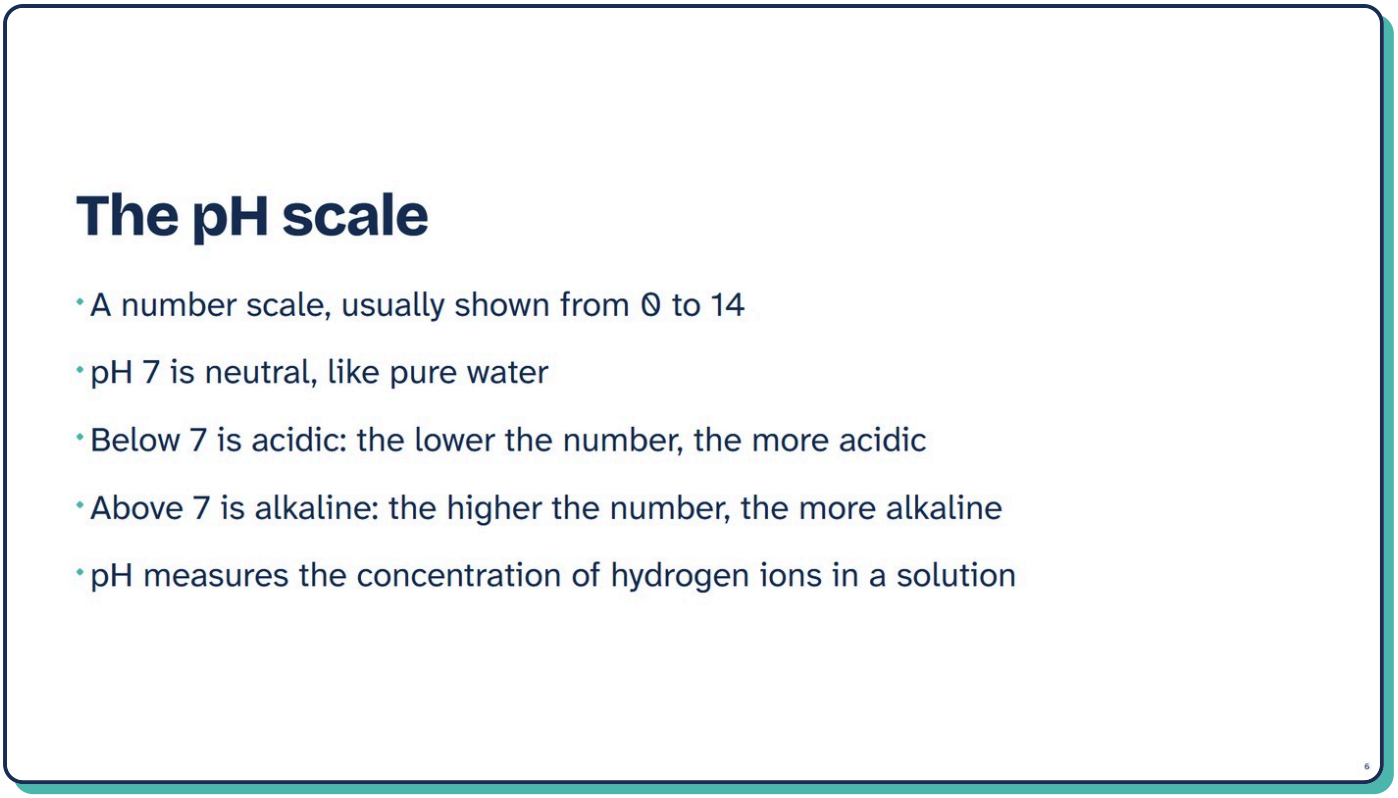

The pH scale

Teacher notes

Stress that a lower pH means more acidic; students often assume a bigger number means a stronger acid. Values below 0 and above 14 are possible for very concentrated solutions, but 0 to 14 covers almost everything met at school. Neutral is exactly pH 7 at 25 °C.

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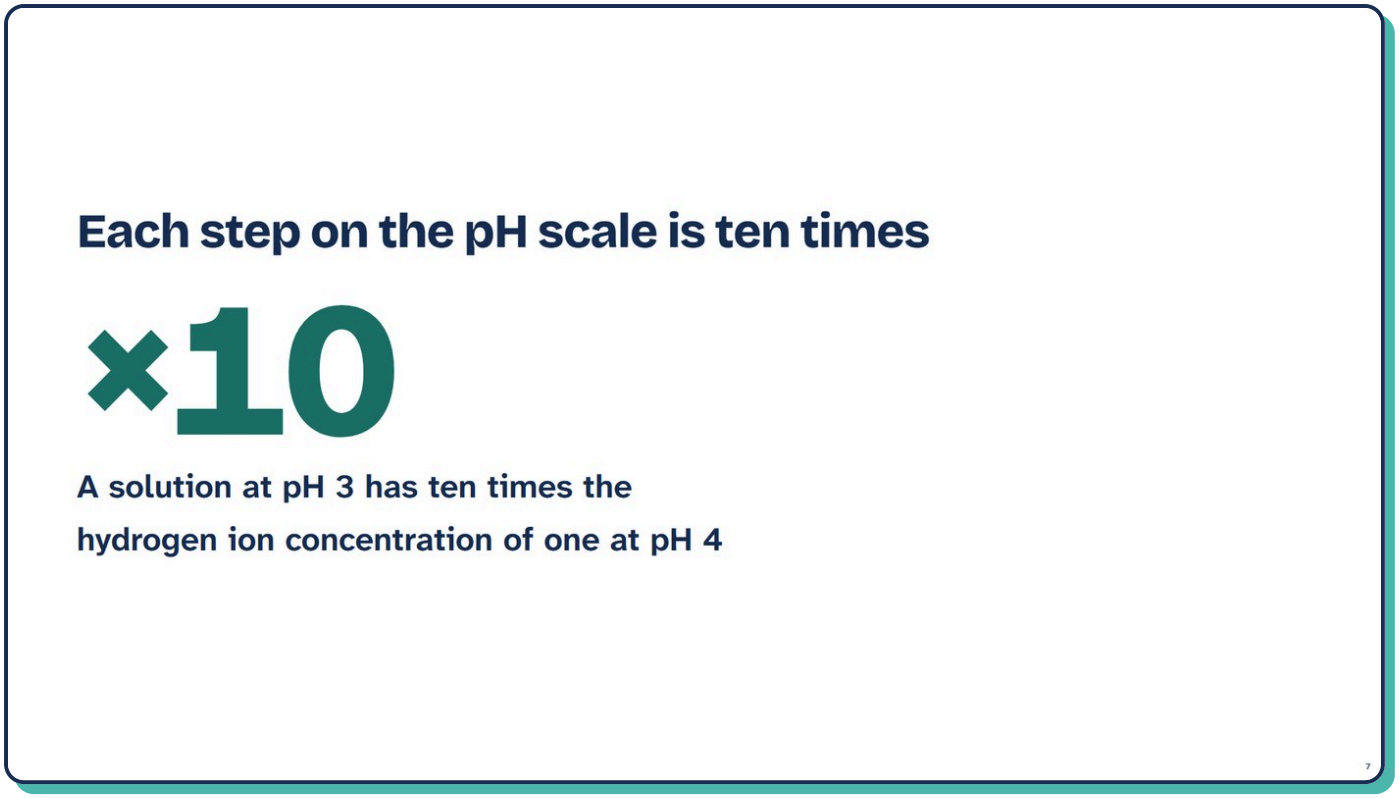


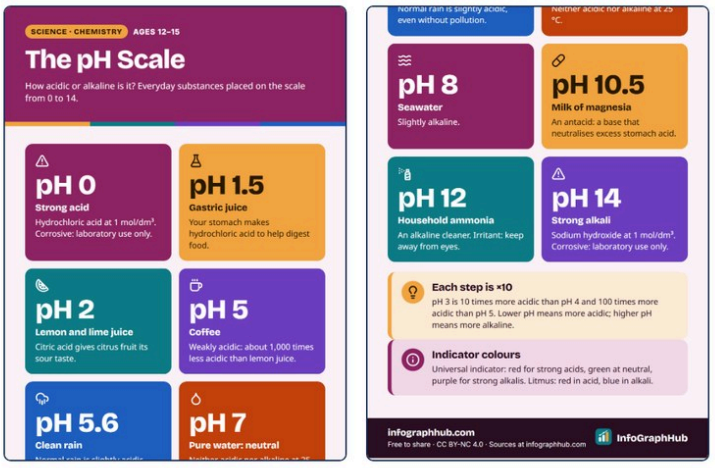
Each step on the pH scale is ten times

Teacher notes

So pH 3 is 10 times more acidic than pH 4, and 100 times more acidic than pH 5. This is why a small change in pH can matter a lot, for example in a fish tank or in the blood. Ask: how many times more acidic is pH 2 than pH 5? Answer: 10 × 10 × 10 = 1,000 times.

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.

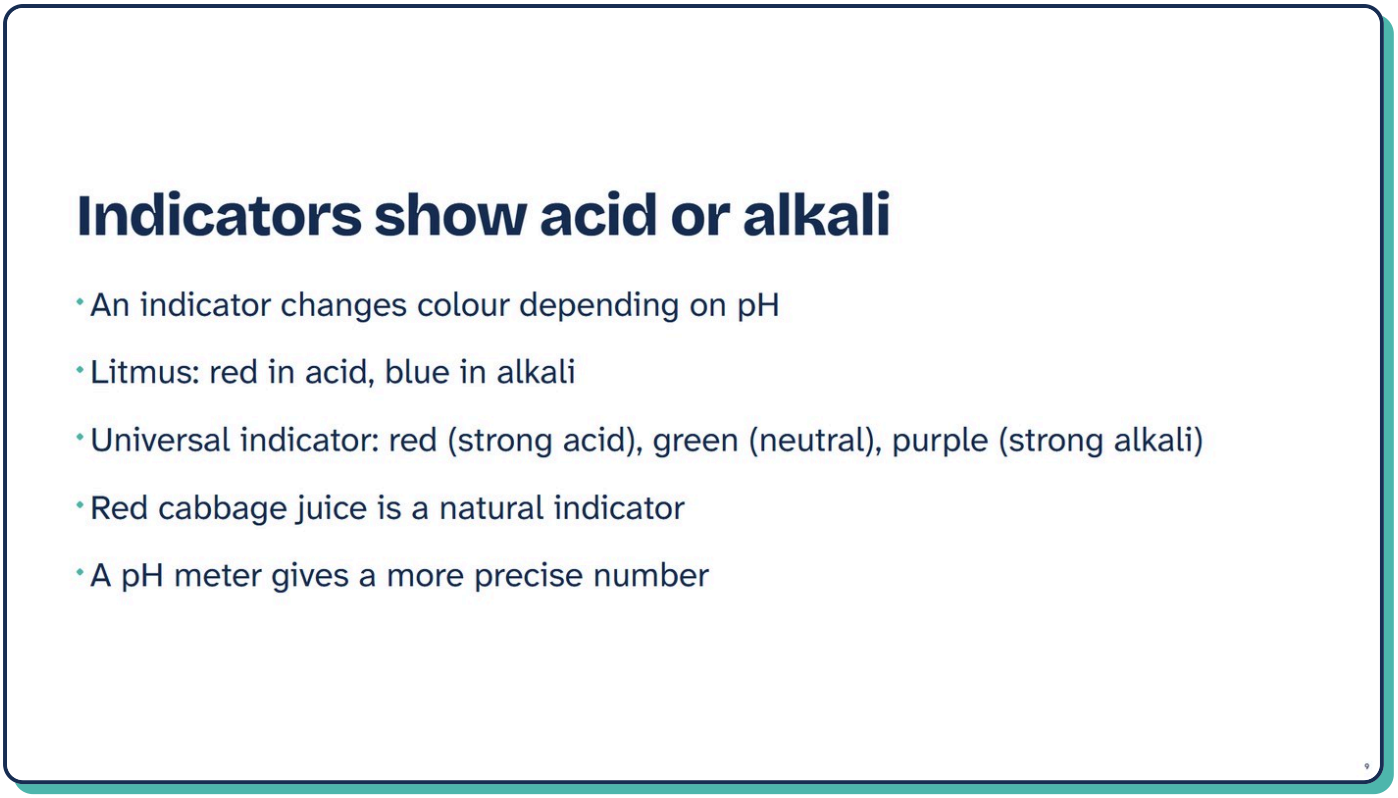


Poster: The pH Scale: Acids, Alkalis and Neutral

Everyday substances on the pH scale

Teacher notes

Use the poster to place everyday substances on the scale: gastric juice about 1.5, lemon juice about 2, coffee about 5, clean rain about 5.6, pure water 7, seawater about 8, milk of magnesia about 10.5, household ammonia about 12. Ask students to predict where their sorted kitchen items will go before they test them.



Indicators show acid or alkali

Teacher notes

Universal indicator is a mixture of several indicators, which is why it shows a whole rainbow of colours instead of just two. Coloured liquids such as cola can hide the indicator colour, which is one reason a pH meter is useful. Universal indicator solution is flammable, so keep it away from Bunsen flames.

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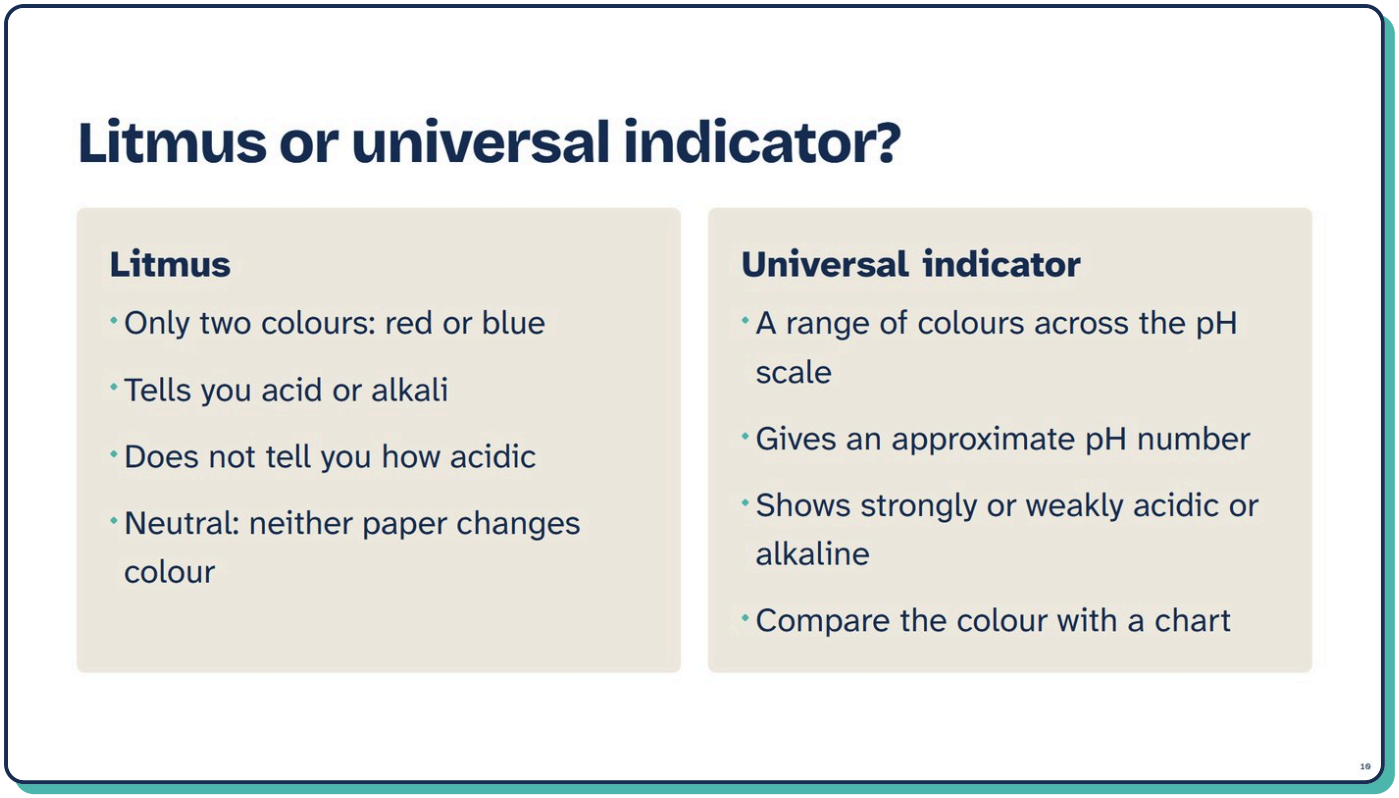
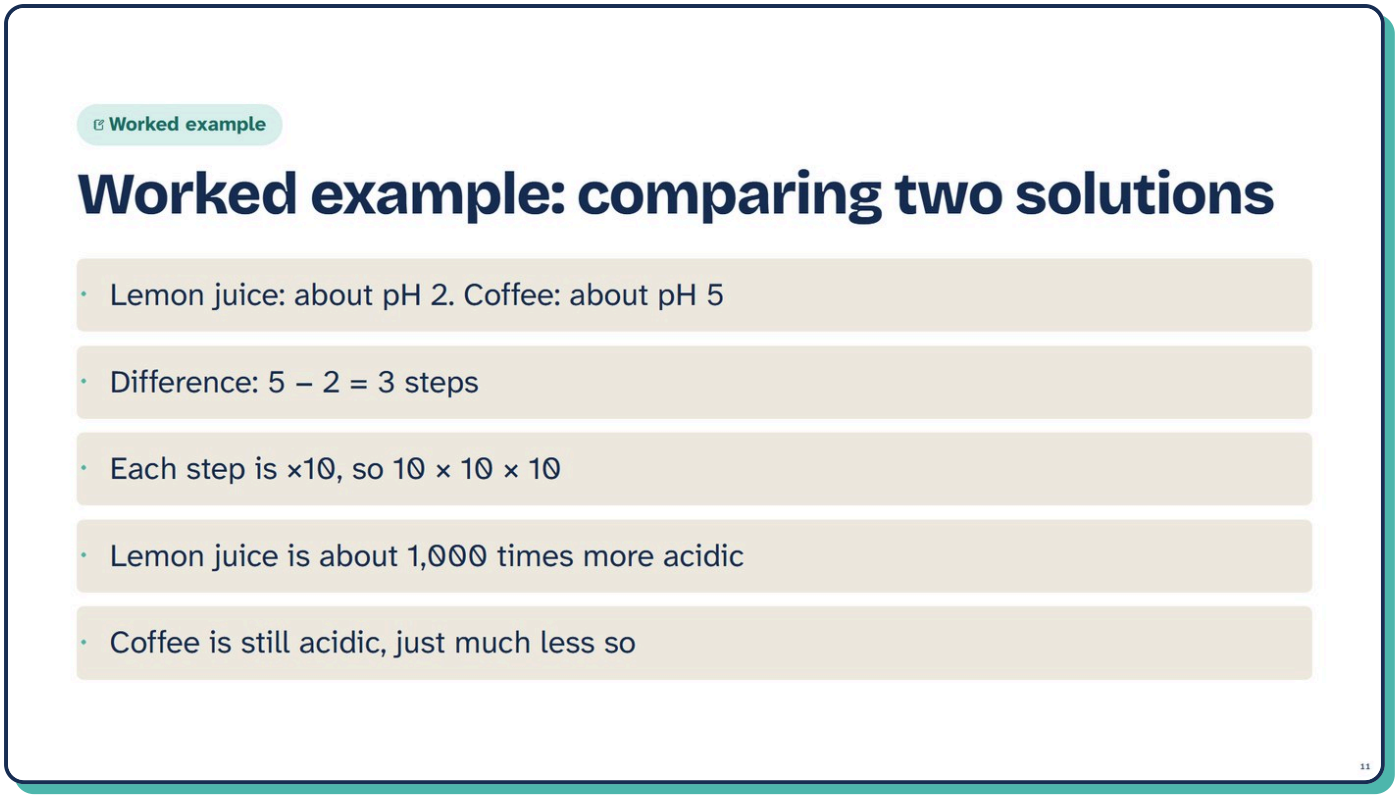


Litmus or universal indicator?

Teacher notes

Common confusion: students expect a positive litmus test always to involve a colour change. Teach the phrases 'turns red', 'stays red', 'turns blue' and 'stays blue'. An acid turns blue litmus red but leaves red litmus red.



Worked example: comparing two solutions

Teacher notes

Work through each line on the board, then give a second pair to try: seawater (about pH 8) and household ammonia (about pH 12). Ammonia is about 10,000 times more alkaline. Remind students that these values are approximate; real samples vary.

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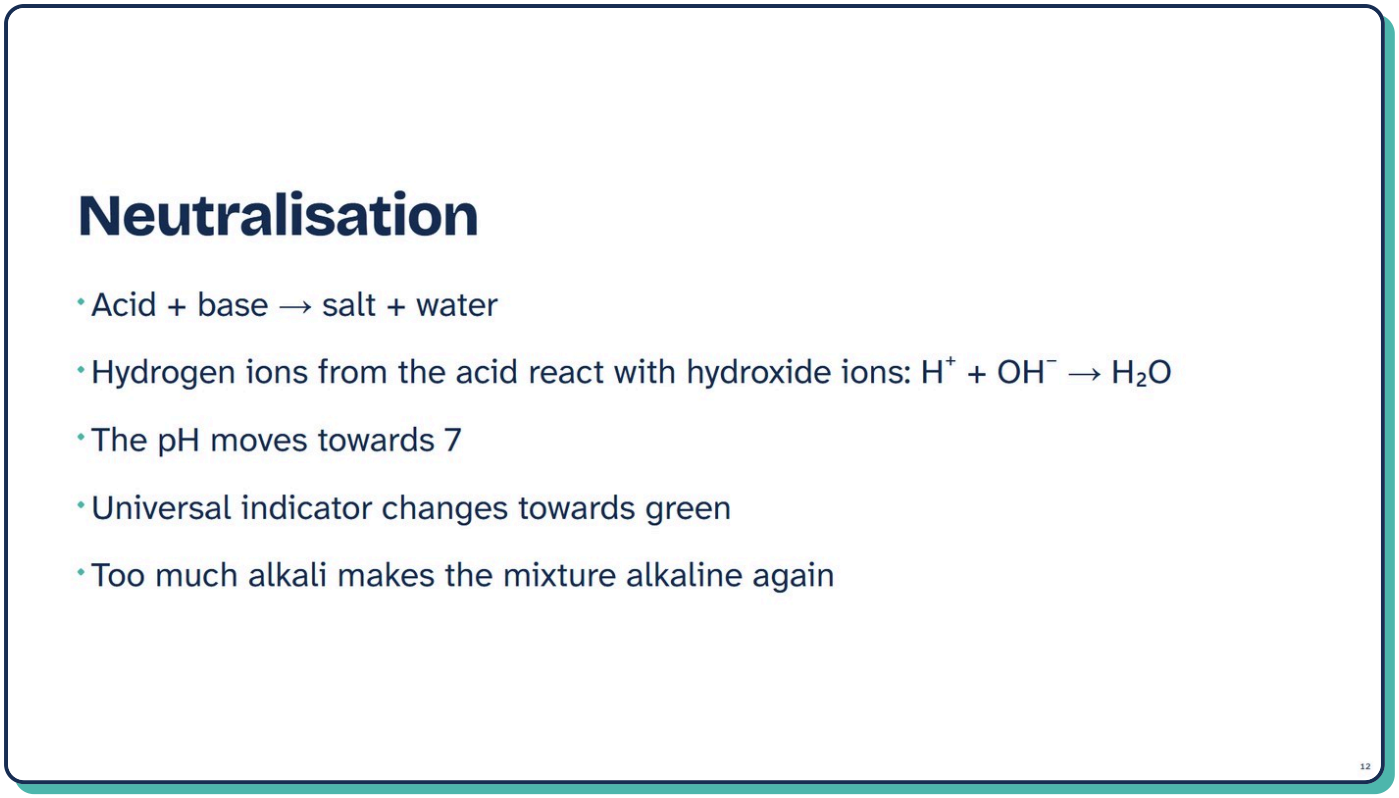

Neutralisation

Teacher notes

In chemistry, 'salt' means a whole family of compounds, not just table salt. Ask students to predict what happens to the colour of universal indicator as alkali is added drop by drop to an acid: red, orange, yellow, then green at neutral, then blue and purple if too much alkali is added.

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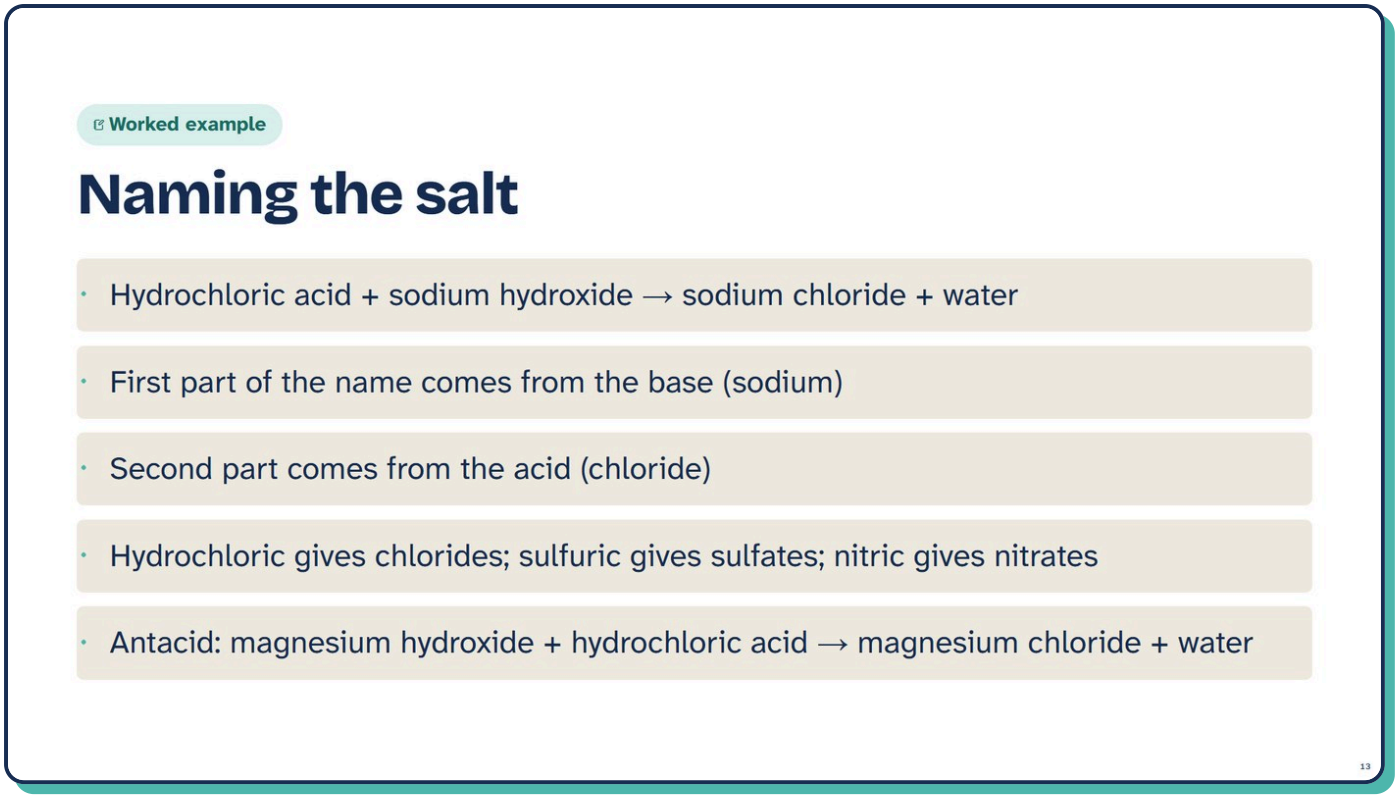
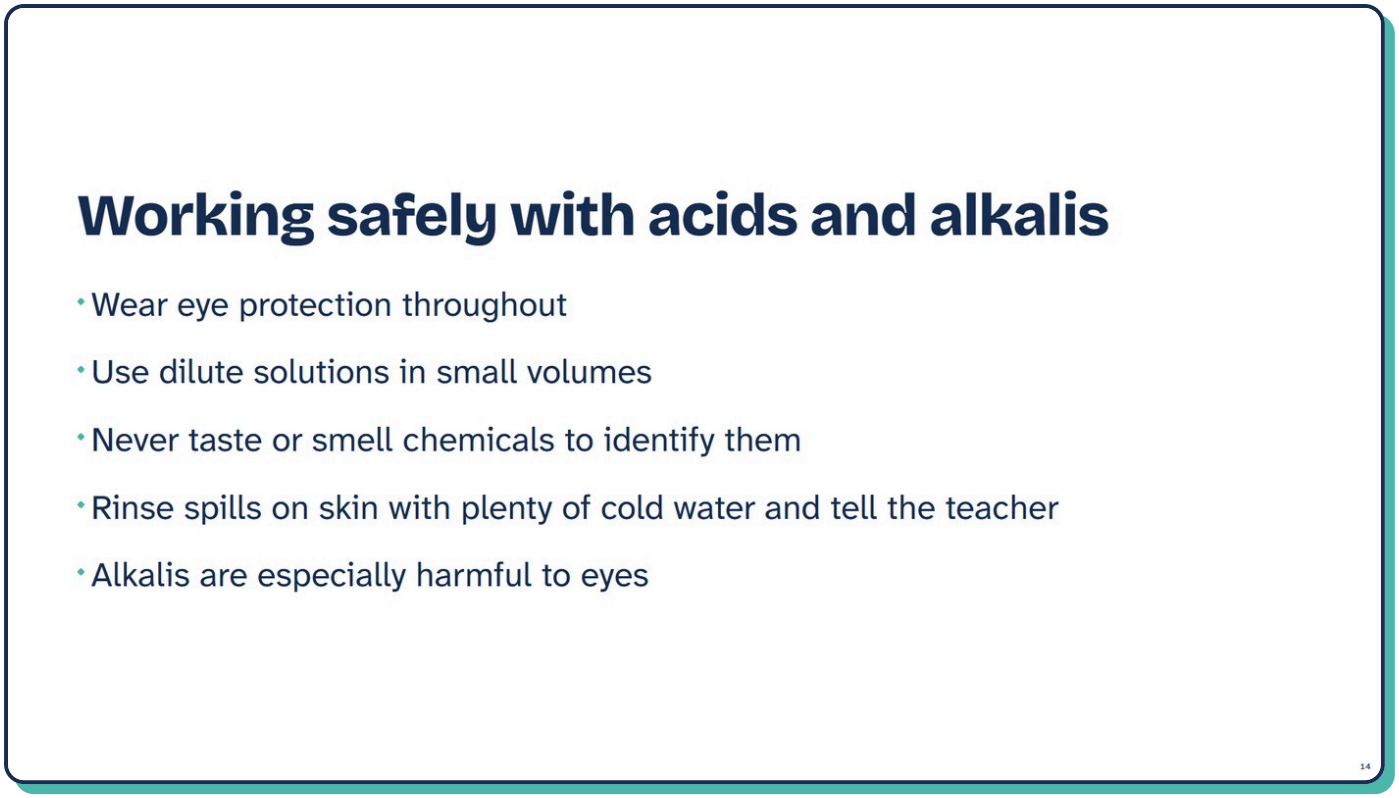


Naming the salt

Teacher notes

Give students three more to name: potassium hydroxide with nitric acid (potassium nitrate), sodium hydroxide with sulfuric acid (sodium sulfate), calcium hydroxide with hydrochloric acid (calcium chloride). Older students can write the balanced symbol equation, for example HCl + NaOH → NaCl + H_2O.



Working safely with acids and alkalis

Teacher notes

Show the hazard symbols on the bottles you will use. Explain that 'dilute' and 'concentrated' describe how much acid is dissolved, while 'strong' and 'weak' describe how fully the acid releases hydrogen ions; older students meet this difference at GCSE and IGCSE level.

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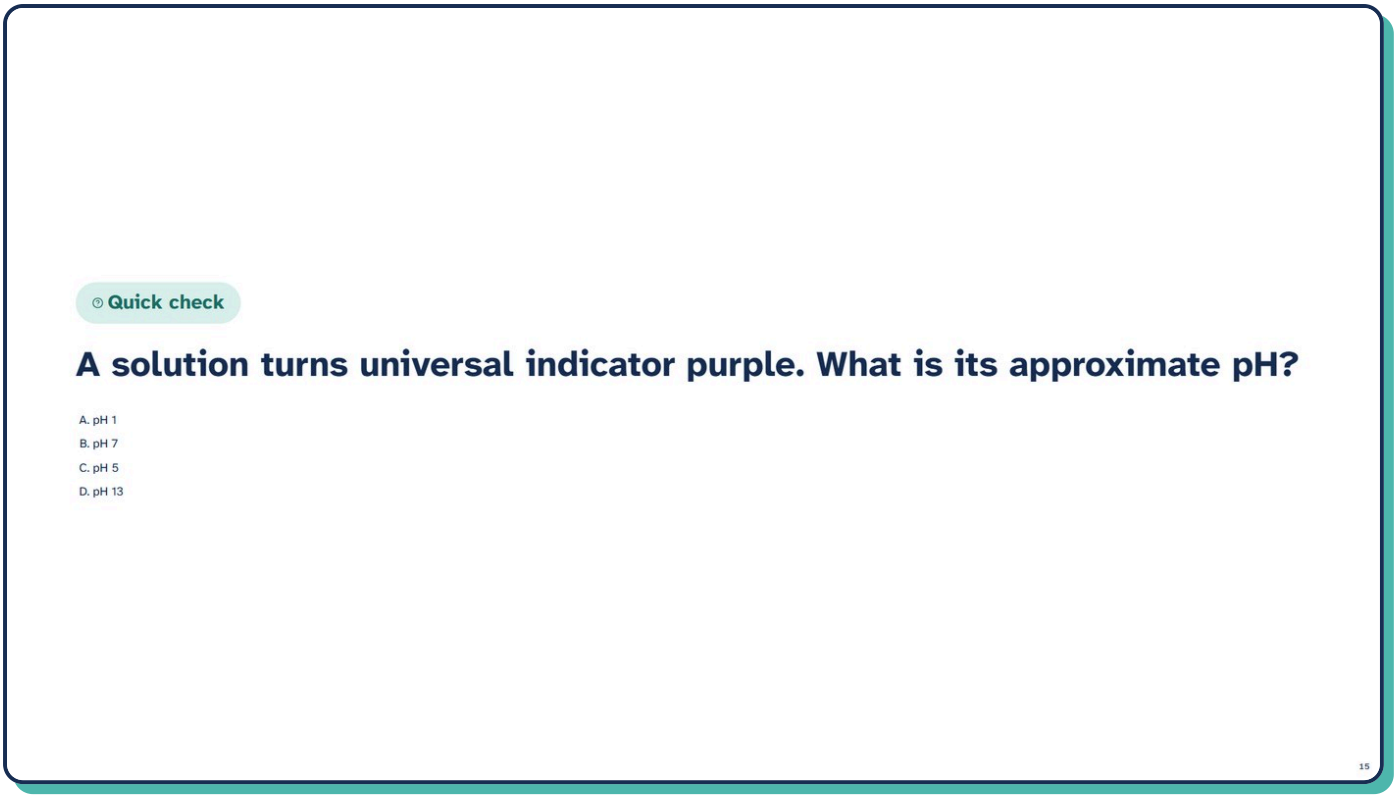

Quick check

Teacher notes

Answer: D, pH 13. Purple means strongly alkaline. Students who chose A have mixed up the two ends of the scale; ask them which colour a strong acid gives (red).

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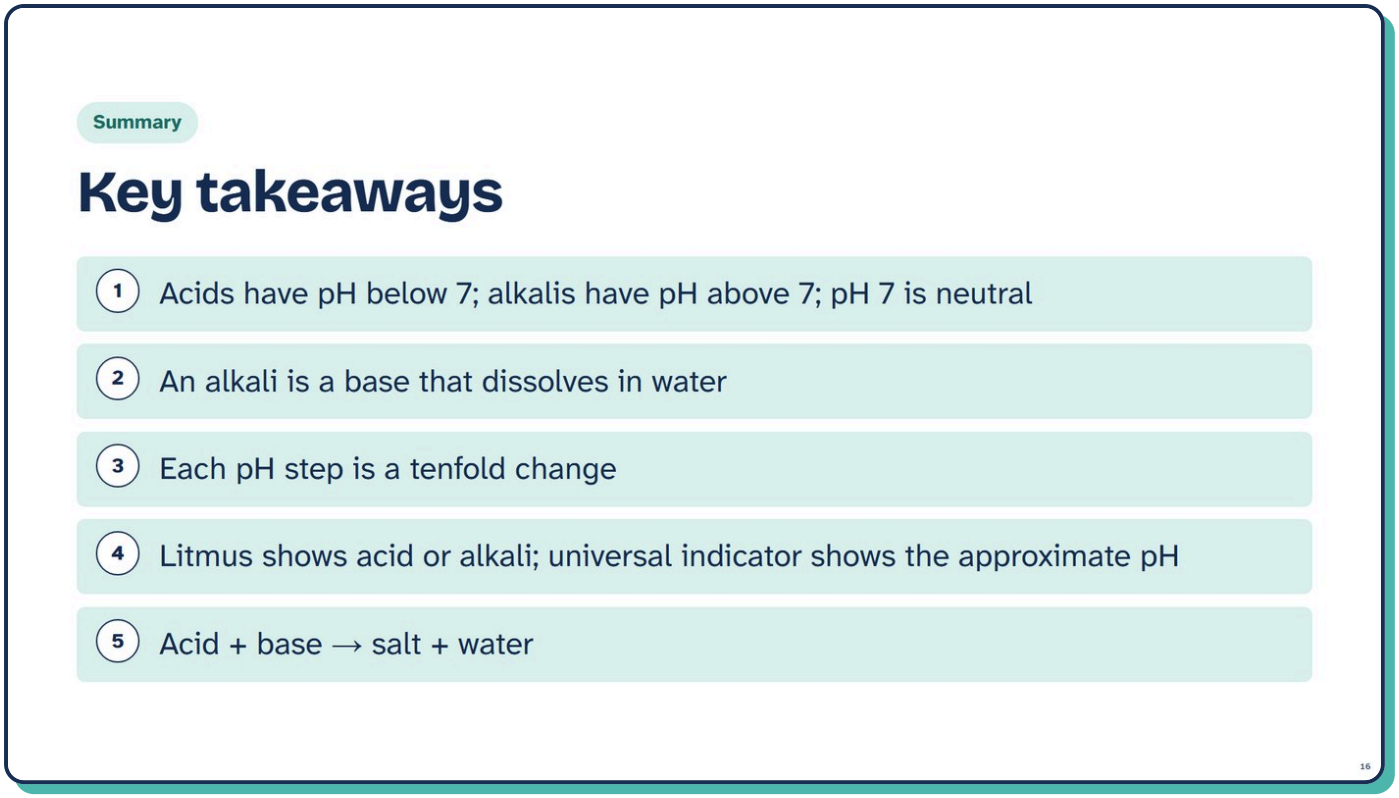

Key takeaways

Teacher notes

Return to the lemon, vinegar and indigestion tablets and ask students to explain how the tablets work, using the word neutralisation. Then move to the five-question quiz. Homework idea: research one use of neutralisation in farming, medicine or industry and explain it in three sentences.

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