

Measuring acidity with the pH scale

Grade 8 science (Year 9 · Class 8) · Lesson

Quick answer: Acids have a pH below 7, alkalis have a pH above 7, and a neutral liquid such as pure water has a pH of exactly 7. The pH scale runs from 0 to 14, and indicators such as litmus or universal indicator change colour to show where a solution sits on that scale.

Level: Grade 8 science (Year 9 · Class 8) · **Curriculum:** MS-PS1-2

What are acids and bases?

Acids and bases are two big families of chemicals that you meet every day. Lemon juice, vinegar and fizzy drinks contain acids. Soap, baking soda and many cleaning liquids contain bases. In a school lab you never taste anything to decide which family it belongs to. You use indicators and the pH scale instead.

Definition

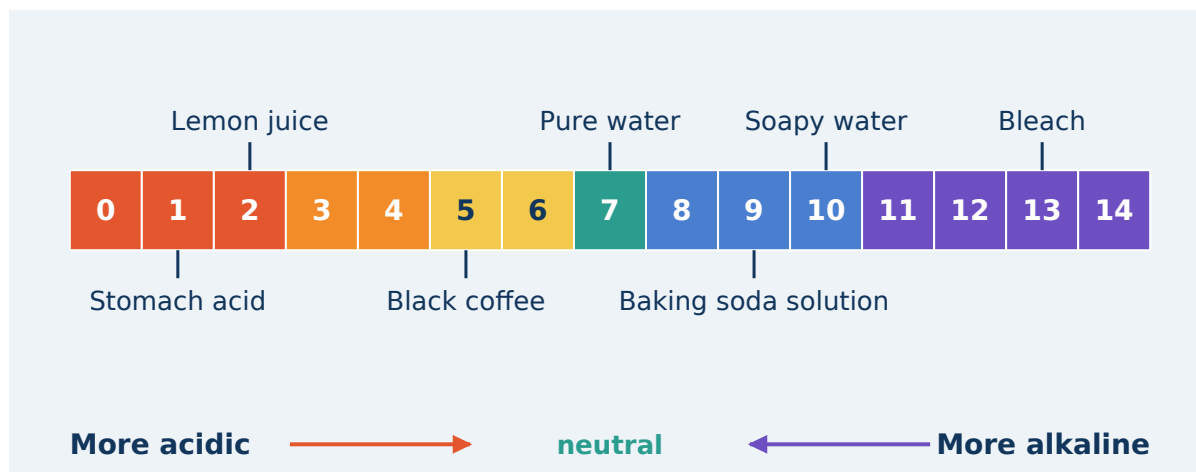
An **acid** is a substance that forms a solution with a pH below 7. Acids taste sour, turn blue litmus red and react with many metals and carbonates.

Definition

A **base** is a substance that reacts with an acid to neutralise it. A base that dissolves in water is called an **alkali**. Alkaline solutions feel slippery, turn red litmus blue and have a pH above 7.

What does the pH scale tell you?

The pH scale is a number line from 0 to 14 that shows how acidic or alkaline a solution is. Pure water sits in the middle at pH 7. Anything below 7 is acidic and anything above 7 is alkaline. The further a value is from 7, the stronger the acid or alkali.



The pH scale with everyday examples. Colours match the universal indicator.

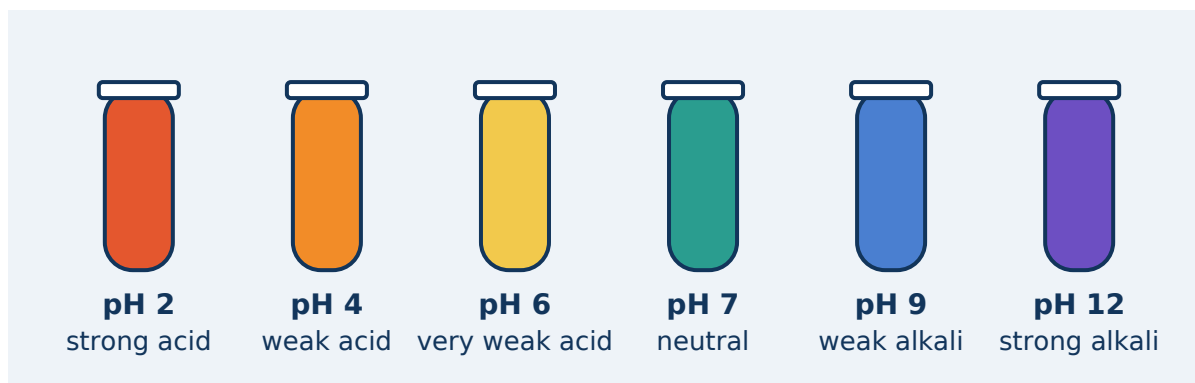
Key law

Each whole step on the pH scale is a tenfold change in acidity. A solution of pH 3 is ten times more acidic than one of pH 4 and one hundred times more acidic than one of pH 5.

Substance	Typical pH	Type
Stomach acid	1 to 2	Strong acid
Orange juice	3 to 4	Weak acid
Rainwater	about 5.6	Very weak acid
Pure water	7	Neutral
Sea water	about 8	Weak alkali
Oven cleaner	13 to 14	Strong alkali

How do indicators show pH?

An indicator is a dye that changes colour with pH. Litmus is red in acid and blue in alkali, but it only tells you which side of 7 you are on. Universal indicator is a mixture of dyes and shows a whole rainbow, so you can estimate the pH. Red cabbage juice is a homemade indicator that works in a kitchen.



Universal indicator colours: red and orange for acids, green for neutral, blue and purple for alkalis.

A pH meter gives a more exact reading, such as 6.8, because a probe measures the solution electronically. Indicators are quick and cheap, while meters are better for careful work.

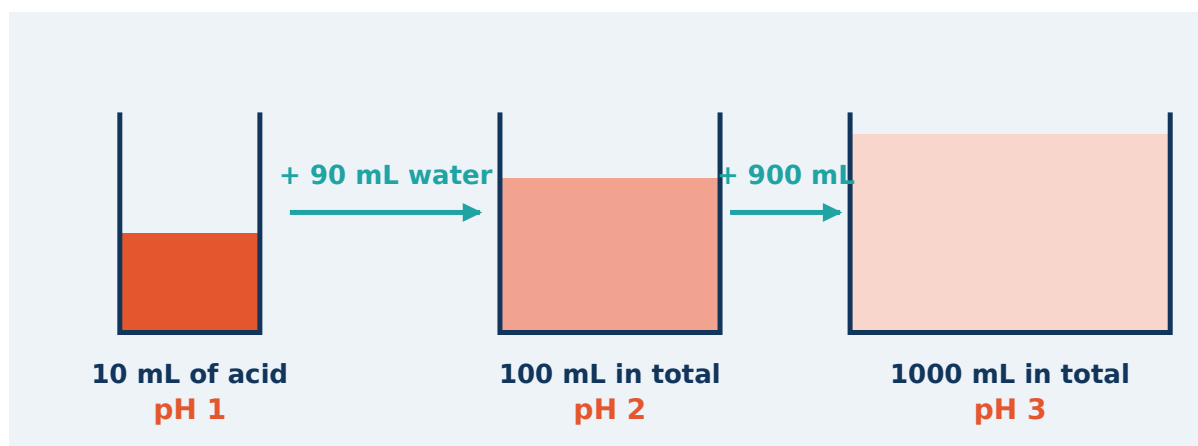
What happens when you dilute an acid?

Diluting means adding water. The acid particles spread through more liquid, so the solution becomes less acidic and its pH moves up towards 7. For a strong acid, such as dilute hydrochloric acid, every tenfold dilution raises the pH by exactly 1.

Formula

Dilution factor = final volume ÷ starting volume

Factor 10 raises a strong acid's pH by 1, factor 100 by 2 and factor 1000 by 3.



Diluting a strong acid tenfold at each step raises the pH by 1.

Worked example

Aarav in Pune dilutes 25 mL of hydrochloric acid of pH 1 by adding water until the total volume is 250 mL.

Factor = $250 \text{ mL} \div 25 \text{ mL} = 10$. The pH rises by 1, so the new pH is **2**.

Worked example

Emma in Leeds pours 5.0 mL of acid of pH 2 into a measuring cylinder and tops it up with water to 500 mL.

Factor = $500 \text{ mL} \div 5.0 \text{ mL} = 100$. The pH rises by 2, so the new pH is **4**.

Adding water can bring a pH close to 7, but never beyond it. Water is neutral, so it cannot turn an acid into an alkali.

Common mistake

Many students think that pH 4 is twice as acidic as pH 8, or that a pH 1 acid becomes pH 8 with enough water. The scale is tenfold per step, and dilution only approaches 7. Weak acids such as vinegar change by less than 1 per tenfold dilution.

How do you handle acids and alkalis safely?

Strong acids and strong alkalis are corrosive, which means they damage skin, eyes and clothes. Weak ones such as vinegar are far less hazardous, but you should still treat every unknown liquid with care.

Safety

Wear goggles. Never taste or sniff a chemical. When you dilute a concentrated acid, add the acid slowly to the water, never water to acid. Wash splashes with plenty of cold water and tell your teacher at once.

Lina's tip

To judge a strength, count steps from 7. A pH of 2 is five steps from 7, which means it is

far stronger than a pH of 6, only one step away.

What is neutralisation?

When an acid reacts with a base, they cancel each other's effect. The products are a salt and water, and the pH moves towards 7. Farmers spread lime on acidic soil, and indigestion tablets neutralise extra stomach acid in the same way.

Reactants	Products	Example use
Acid + alkali	Salt + water	Treating acidic lake water
Acid + metal carbonate	Salt + water + carbon dioxide	Fizzing of an antacid in water

Key points to remember

- pH below 7 is acidic, pH 7 is neutral and pH above 7 is alkaline.
- Each whole pH step means a tenfold change in acidity.
- Universal indicator: red and orange are acids, green is neutral, blue and purple are alkalis.
- Diluting a strong acid tenfold raises its pH by 1 but never beyond 7.
- Dilution factor = final volume ÷ starting volume.

Measuring acidity with the pH scale: frequently asked questions

What is the pH of a neutral solution?

A neutral solution has a pH of 7 at room temperature. Pure water is the usual example, and universal indicator turns green in it.

What is the difference between a base and an alkali?

A base is any substance that neutralises an acid. An alkali is a base that dissolves in water. All alkalis are bases, but not every base is an alkali.

Why does the pH go up when you add water to an acid?

Water spreads the acid particles through a bigger volume, so the solution is less acidic. The pH rises towards 7 but can never pass it.

Which indicator is best for finding an exact pH?

A pH meter is best because it reads values such as 5.4. Universal indicator gives a good estimate, and litmus only shows acid or alkali.

Is it safe to test chemicals by tasting them?

No. Many acids and alkalis burn skin and mouth. Always use an indicator or a pH meter and wear goggles.