

How much solute can dissolve in water

Grade 7 science (Year 8 · Class 7) · Lesson

Quick answer: Solubility is the maximum mass of a solute that dissolves in 100 g of water at a given temperature. When that limit is reached the solution is saturated. For most solids solubility rises with temperature, and concentration is measured in grams per litre as mass of solute divided by volume of solution.

Level: Grade 7 science (Year 8 · Class 7) · **Curriculum:** MS-PS1-2

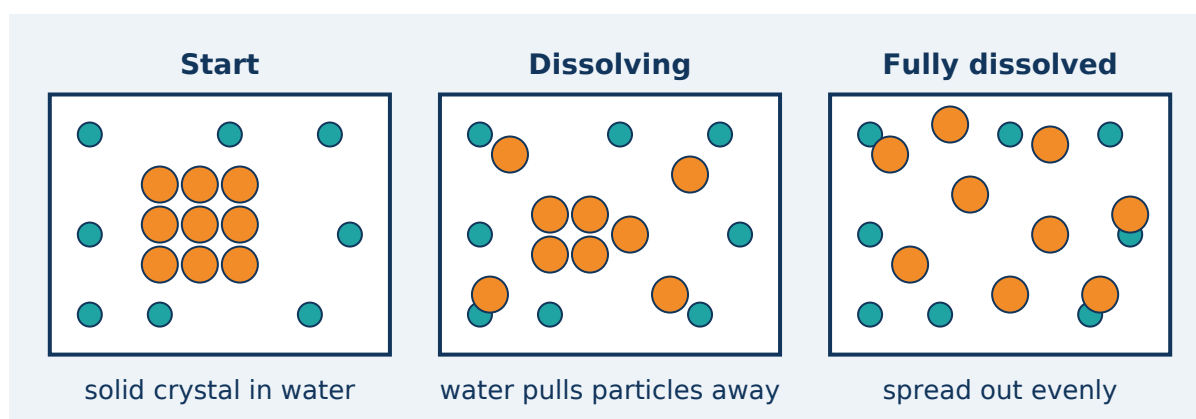
What does it mean to dissolve?

When you stir sugar into tea, the crystals vanish but the tea tastes sweet. The sugar has not disappeared: it has dissolved. A dissolved substance is spread through the liquid as separate particles too small to see, so the liquid stays clear and nothing settles at the bottom.

Definition

A **solute** is the substance that dissolves. A **solvent** is the liquid it dissolves in. Together they make a **solution**. In sugar water, sugar is the solute, water is the solvent and sugar water is the solution.

Dissolving happens because the water particles pull on the particles at the surface of the solid and drag them away one by one. The freed particles then spread out between the water particles by diffusion.



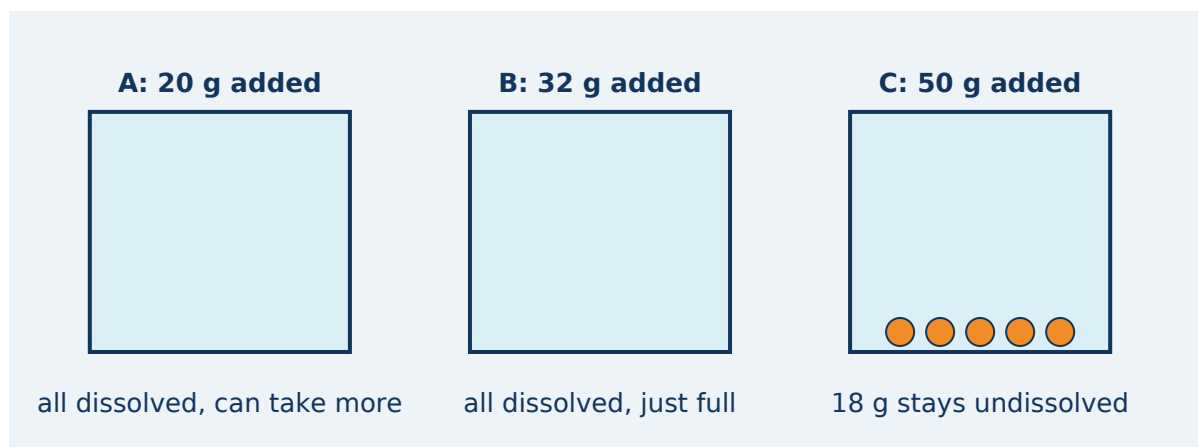
Dissolving: water particles pull solute particles out of the crystal, and diffusion spreads them.

What is a saturated solution?

A solvent can hold only a limited amount of a solute at a given temperature. When that limit is reached, any extra solid stays at the bottom, however long you stir. The solution is then **saturated**.

Definition

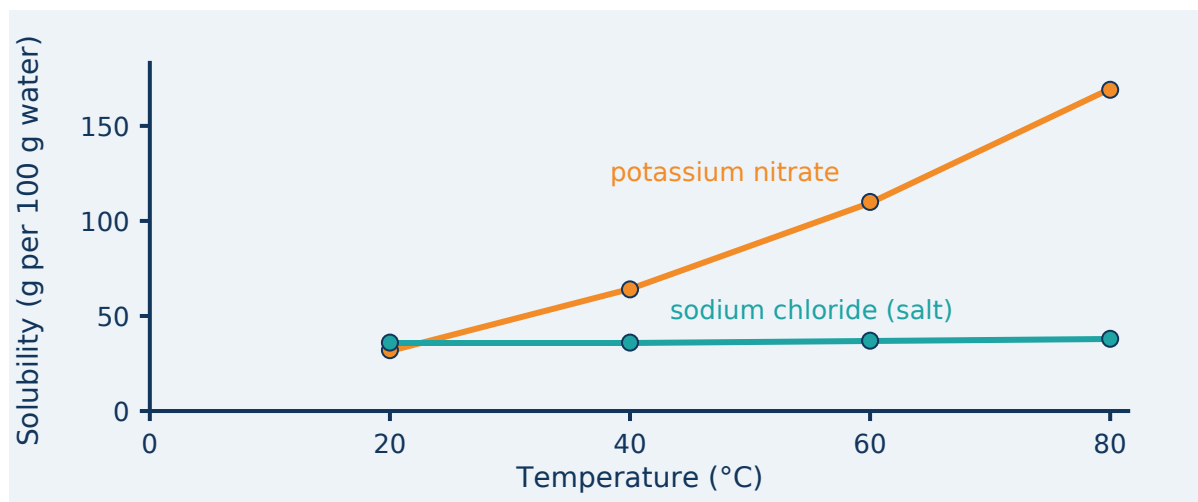
Solubility is the maximum mass of a solute that dissolves in 100 g of water at a stated temperature. A solution that holds this maximum amount is **saturated**. A solution holding less is **unsaturated**.



Unsaturated, just saturated and saturated with excess solid.

How does temperature change solubility?

For most solids the solubility rises as the water gets hotter. Potassium nitrate is a strong example: 100 g of water dissolves 32 g at 20 °C but 169 g at 80 °C. A few solids, such as common salt, hardly change. Gases behave the opposite way: they dissolve better in cold water, which is why a warm fizzy drink loses its bubbles faster.



Solubility of two solids in water against temperature.

Temperature (°C)	Potassium nitrate (g per 100 g water)	Sodium chloride (g per 100 g water)
20	32	36
40	64	36
60	110	37
80	169	38

This is why crystals appear when a hot saturated solution cools. The cold water can hold less,

so the extra solute comes out as solid crystals.

Worked example 1

Pooja in Pune saturates 100 g of water with potassium nitrate at 60 °C, then cools it to 20 °C. **What mass of crystals forms?** At 60 °C the water holds 110 g and at 20 °C it holds 32 g. Crystals = 110 g - 32 g = 78 g. **Answer: 78 g of crystals.**

What is concentration, and how do you calculate it in g/L?

Two sugar solutions can both be unsaturated but one tastes much sweeter. Concentration tells you how much solute is in a given volume of solution. In school science it is often measured in grams of solute per litre of solution.

Formula

Concentration (g/L) = mass of solute (g) ÷ volume of solution (L). Here **c** is the concentration in g/L, **m** is the mass of solute in g, and **V** is the volume of the solution in litres (L).

Worked example 2

Emeka in Lagos dissolves 12 g of sugar in water to make 250 mL of drink. **Find the concentration in g/L.** Convert: 250 mL = 0.250 L. Concentration = 12 g ÷ 0.250 L = 48 g/L. **Answer: 48 g/L.**

Worked example 3

A cook needs 500 mL of brine at 20 g/L. **What mass of salt is needed?** $V = 0.500 \text{ L}$. Mass = concentration × volume = 20 g/L × 0.500 L = 10 g. **Answer: 10 g of salt.**

How can you make a solute dissolve faster?

Three actions speed up dissolving: stirring, heating and crushing the solid into smaller pieces. Each brings fresh solvent against the solid or gives particles more energy. Notice that stirring and crushing do not change how much can dissolve: they only change how fast. Heating does both, because it also changes the solubility of most solids.

Common mistake

Do not confuse dissolving with melting. Melting turns a solid into a liquid by heating it. Dissolving mixes a solid into a liquid. Also, the mass is not lost: the mass of a solution equals the mass of the solvent plus the mass of the solute.

Lina's tip

Always change millilitres to litres before you use g/L. Divide the number of mL by 1000: 250 mL becomes 0.250 L, and 1500 mL becomes 1.5 L.

Key points to remember

- Solute dissolves in a solvent to make a solution.
- A saturated solution holds the maximum solute possible at that temperature.
- Most solids are more soluble in hot water; gases are less soluble.
- Concentration (g/L) = mass of solute (g) ÷ volume of solution (L).
- Stirring, heating and crushing make dissolving faster.

How much solute can dissolve in water: frequently asked questions

What is the difference between solute, solvent and solution?

The solute is the substance that dissolves, the solvent is the liquid that does the dissolving, and the solution is the mixture of the two. In salt water, salt is the solute and water is the solvent.

What does a saturated solution mean?

A saturated solution holds the maximum mass of solute that can dissolve at that temperature. Adding more solute simply sinks to the bottom as undissolved solid.

Why does heating make most solids dissolve better?

Hotter solvent particles move faster and hit the solid harder and more often, pulling particles away more easily. For most solids the solubility rises with temperature, but gases are the opposite.

How do you calculate concentration in g/L?

Divide the mass of solute in grams by the volume of the solution in litres. For 12 g in 250 mL (0.250 L) the concentration is $12 \div 0.250 = 48$ g/L.

Does stirring change how much solid can dissolve?

No. Stirring only makes the solid dissolve faster by bringing fresh solvent to the surface. The maximum amount that can dissolve is set by the solubility at that temperature.