

Where Did the Sugar Go?

*The vanishing act of Solutes,
Solvents and Solutions*



INSTITUTE Prodigy Educlasses	CLASS VIII (Class 8)	BOARD CBSE / ICSE / WB Board
TOPIC Solute, Solvent and Solution	CHAPTER / UNIT Solutions and their properties	FACULTY Surajit Sir (Chemistry)

Hello, my curious friends! Here is a magic trick you can do at breakfast.

Drop a spoon of sugar into your hot chai and stir. In ten seconds the sugar is gone. You cannot see it, you cannot fish it out with a spoon, yet the first sip tastes sweet. So where did the sugar go? Did it disappear? Did it turn into water? Neither. The sugar is still there, broken into pieces too tiny to see. That hidden, invisible world is what we explore today.

The Mystery Box: 4 questions to keep in your head

- If sugar does not vanish, where exactly is it hiding inside the tea?
- Can a glass of water refuse to dissolve any more sugar? (Yes! Find out why.)
- Why does a fizzy drink go flat much faster in a warm room than in the fridge?
- Why do scuba divers have to come up to the surface slowly?

1 Meet the cast: solute, solvent, solution

Every solution has two main characters. Take your chai. The **sugar** is the one that gets dissolved. We call it the **solute**. The **water** is the one doing the dissolving. That is the **solvent**. When they mix and become one uniform liquid, that liquid is the **solution**.

Solute + Solvent → Solution

Here is a simple way to remember it. The solvent is usually the boss: it is present in the larger amount and it decides whether the solution will be a liquid, a solid or a gas. The solute is the guest that mixes in.

Solution	Solute	Solvent	Fun detail
Sweet tea	Sugar	Water	A water solution is called an aqueous solution
Tincture of iodine	Iodine	Alcohol	The brown antiseptic on your first-aid box
Soda water	Carbon dioxide (gas)	Water	The fizz is the gas escaping
Vinegar	Acetic acid	Water	About 5 to 8% acid
Brass	Zinc	Copper	A solid dissolved in a solid!

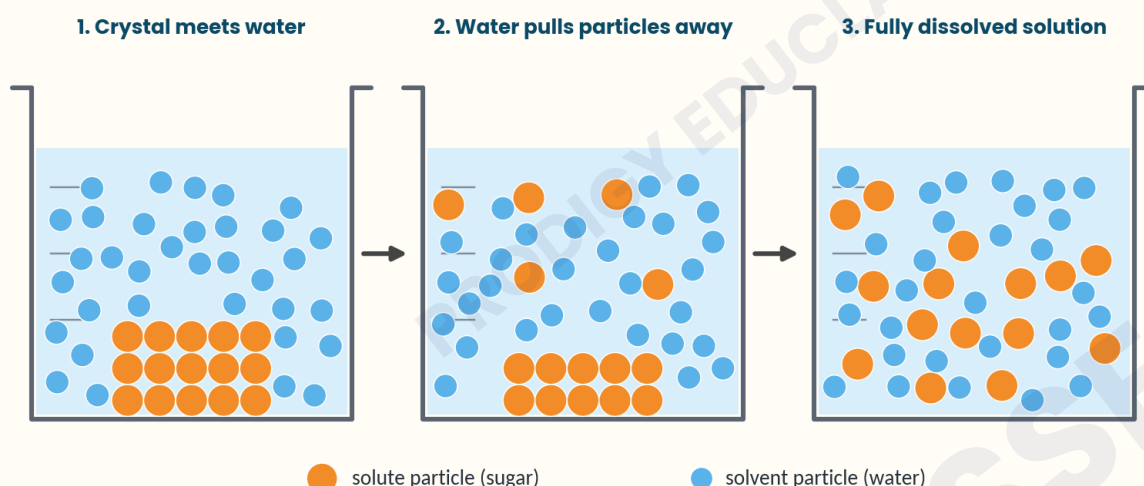


Fig 1. What really happens when sugar dissolves. The crystal breaks up and its particles spread evenly between the water particles.

Notice something important in Figure 1: nothing was destroyed. The sugar particles are all still there. Dissolving is a **physical change**: if you evaporate the water, the sugar comes back.

Did you know?

Water is often called the **universal solvent** because it dissolves more substances than any other common liquid. But the title is a little exaggerated: oil, wax and paint do not dissolve in water. Nail polish does not either, which is why we use acetone (nail-polish remover) as the solvent for that job.

2 What makes a solution special?

Stir chalk powder into water and it looks cloudy. Stir salt into water and it looks clear. Both are 'mixtures', but only one is a true solution. A true solution has four signature features:

- **Homogeneous.** Every spoonful has exactly the same composition. The top of the glass is as sweet as the bottom.
- **Tiny particles.** The particles are smaller than 1 nanometre, far too small to see even with a microscope.
- **Stable.** Leave it for a week and nothing settles at the bottom.
- **Cannot be filtered.** The particles are so small that they pass right through filter paper. And the light beam is not scattered.

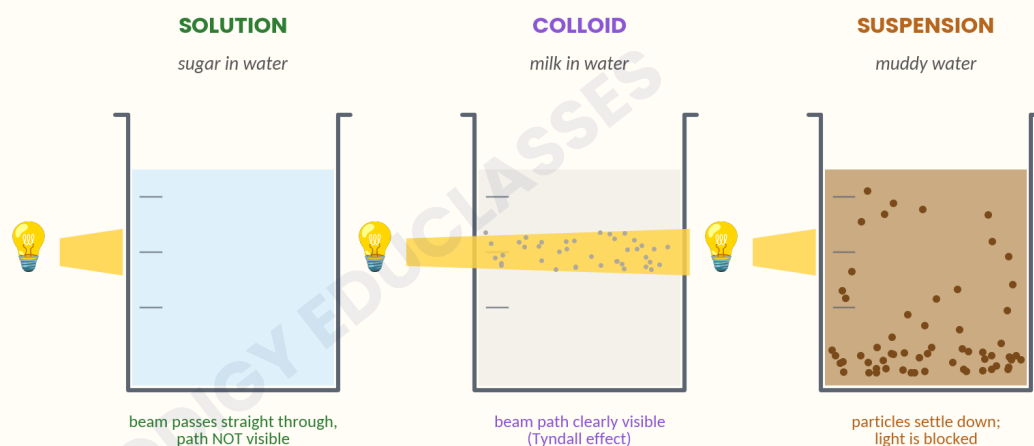


Fig 2. Shine a torch through three liquids. Only a colloid lights up its own path. This is called the Tyndall effect.

Property	True solution	Colloid	Suspension
Particle size	Less than 1 nm	1 nm to 1000 nm	More than 1000 nm
Looks	Clear, transparent	Cloudy or milky	Muddy, opaque
Settles on standing?	Never	Never (stable)	Yes, slowly
Filter paper	Passes through	Passes through	Gets stuck on it
Scatters light?	No	Yes (Tyndall effect)	Yes, but blocks it
Examples	Sugar water, salt water, soda	Milk, fog, ink, butter	Muddy water, chalk in water

Try This at Home

The torch test. In a dark room, shine a phone torch through three glasses: clear sugar water, water with a few drops of milk, and muddy water. Which one shows a glowing beam? That is your colloid. Do you know why sunbeams look like solid rods when they pass through a dusty room? Same effect: dust and mist scatter the light.

3 Solutions come in many flavours

Most people think a solution must be a liquid. Not true! Because the solvent decides the state, a solution can be a gas, a liquid or even a solid.

Solute	Solvent	Example	In daily life
Solid	Liquid	Sugar in water	 Every cup of sweet tea
Gas	Liquid	Carbon dioxide in water	 Soft drinks and soda
Liquid	Liquid	Alcohol in water	 Antiseptics, many medicines
Gas	Gas	Oxygen etc. in nitrogen	 Air is a solution of gases
Solid	Solid	Zinc in copper	 Brass, steel, bronze, 22-carat gold

Did you know?

Gold jewellery is a solid solution. Pure 24-carat gold is very soft. Jewellers dissolve some copper or silver into it to make it stronger. 22-carat gold means 22 parts of gold in 24 parts of the alloy, which is about 91.7% gold.

4 Can a glass be 'full' of sugar?

Yes, in the chemical sense. Keep adding spoons of sugar to a glass of water and stirring. At first each spoon vanishes. After a while, the sugar stops dissolving and sits at the bottom no matter how hard you stir. The water has reached its limit. The maximum amount of a solute that dissolves in 100 g of solvent at a given temperature is called its **solubility**.

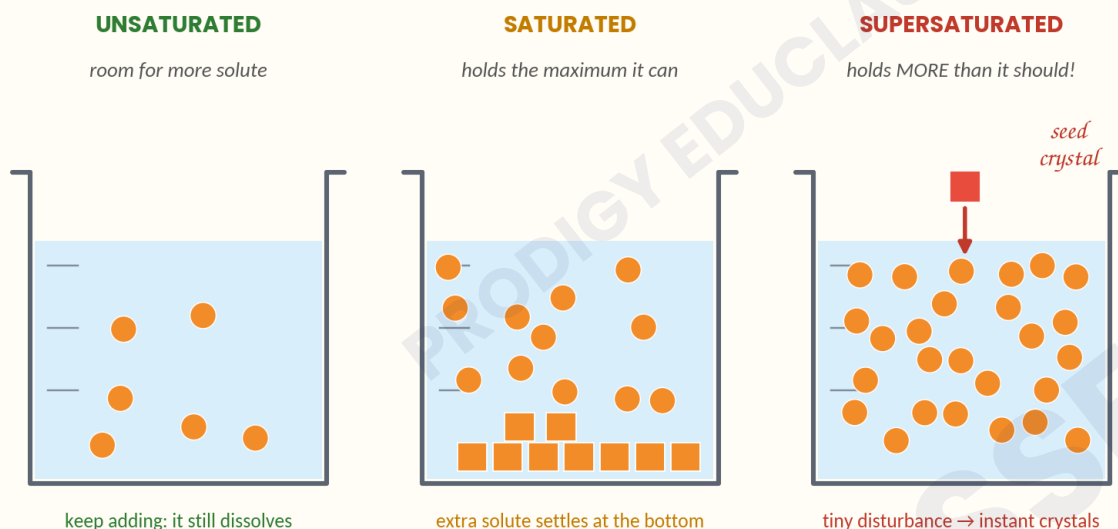


Fig 3. Three states of a solution: unsaturated, saturated, and the rare supersaturated one.

- **Unsaturated:** it can still dissolve more solute at that temperature.
- **Saturated:** it has dissolved the maximum. Extra solute stays undissolved.
- **Supersaturated:** made by dissolving a lot in a hot solution and cooling it very gently. It holds more than it normally should, like a crowded bus about to burst. One tiny seed crystal makes the extra solute crash out instantly.

🔥 Did you know?

The 'hot ice' hand warmer. Those click-to-heat pouches contain a supersaturated solution of sodium acetate. Click the little metal disc and crystals rush through the pouch like ice forming in fast-forward, and heat is released. Boil the pouch in water to dissolve the crystals again and it is ready to be reused.

Substance	Approx. solubility in 100 g water at 20 °C	What it tells you
Sugar (sucrose)	about 200 g	Extremely soluble. That is why syrup can be so thick
Common salt	about 36 g	Moderately soluble
Potassium nitrate	about 32 g	Its solubility rockets up when heated
Baking soda	about 10 g	Only slightly soluble
Slaked lime (lime water)	about 0.17 g	Barely dissolves
Chalk (calcium carbonate)	almost nothing	Practically insoluble

Try This at Home

The spoon-counting challenge. Take half a glass of cold water. Add sugar one level spoon at a time, stirring well, until a spoon stops dissolving. Count the spoons. Now repeat with hot water (ask an adult to pour). Which one took more spoons? Write your result in the table below.

Water	Spoons of sugar that dissolved	What you noticed
Cold water		
Warm / hot water		

5 What changes solubility?

Scientists love to ask 'what happens if I change one thing?'. Let us do that. Look at the graph on the left first. Potassium nitrate dissolves in hot water by the bucketful, while common salt barely cares about temperature.

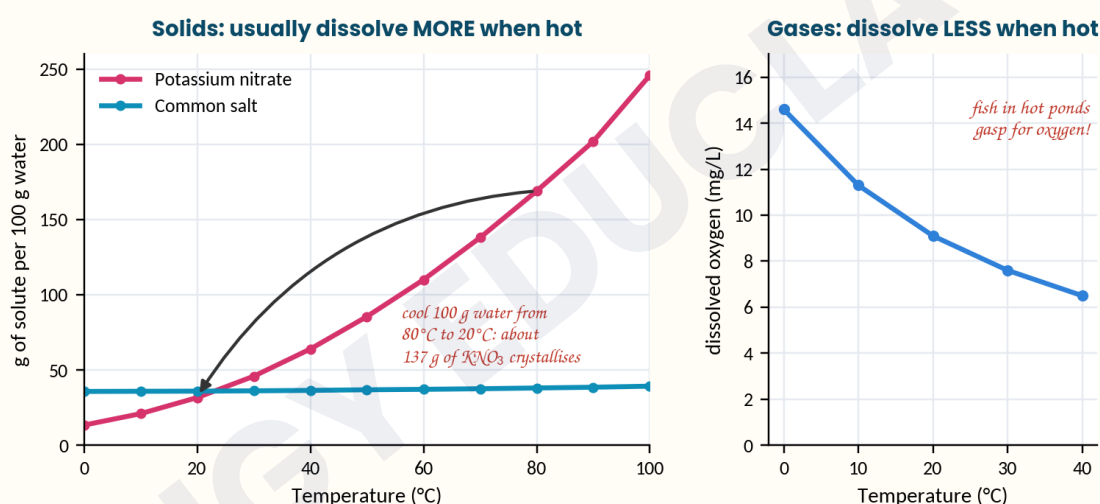


Fig 4. Left: solubility of two solids at different temperatures (approximate values). Right: dissolved oxygen in water falls as the water warms.

Teacher's Trick

Reading the graph. Every point on the curve means 'this much is the maximum'. Below the curve, the solution is unsaturated. On the curve, it is saturated. Suppose a saturated solution of KNO₃ in 100 g water at 60 °C is cooled to 20 °C. Solubility falls from about 110 g to about 32 g, so roughly **110 – 32 = 78 g of crystals** will appear.

⚠ Careful! Common Mistake

Rate is not amount! Stirring, powdering the solute and heating make a solid dissolve *faster*. They do not always change *how much* can dissolve. Powdered sugar disappears sooner than a sugar cube, but a glass of water still has the same limit. Speed and capacity are two different ideas. Examiners love this one.

Factor	What happens	Everyday link
Temperature (solids)	Most solids dissolve more when hot	Sugar vanishes faster in hot tea
Temperature (gases)	Gases dissolve less when hot	A warm soft drink goes flat quickly. Fish struggle in hot, still ponds
Pressure (gases)	More pressure pushes more gas into the liquid	Soft drinks are sealed under pressure. Opening the cap lets the gas escape as bubbles
Nature of solute and solvent	'Like dissolves like'	Sugar dissolves in water but not in oil. Grease dissolves in petrol, not in water

Did you know?

Why divers rise slowly. Deep underwater, the pressure is high and extra nitrogen dissolves in a diver's blood. If the diver shoots up too fast, the nitrogen bubbles out of the blood, just like the fizz when you open a shaken soda bottle. That painful condition is called 'the bends'. Slow ascent lets the gas leave gently.

Did you know?

The Dead Sea. Its water carries roughly nine to ten times more salt than ordinary seawater. It is so dense that people float without effort and can read a newspaper while lying on it.

6 How strong is my solution?

'Strong tea' and 'weak tea' are fine at home, but in a hospital or lab we need exact numbers. One easy way is the **mass percentage**: how many grams of solute are there in every 100 g of **solution**?

$$\text{Mass \% of solution} = (\text{mass of solute} \div \text{mass of solution}) \times 100$$

Example 1. 20 g of sugar is dissolved in 80 g of water. What is the concentration?

Mass of solution = 20 + 80 = 100 g. So mass % = $(20 \div 100) \times 100 = 20\%$.

Example 2. 5 g of salt is dissolved in 45 g of water.

Mass of solution = 5 + 45 = 50 g. So mass % = $(5 \div 50) \times 100 = 10\%$.

Example 3. How much salt is needed for 250 g of a 10% salt solution?

Salt = 10% of 250 g = 25 g. So dissolve **25 g of salt in 225 g of water**.

Exam Alert

The bottom line of the formula is the mass of the **whole solution** (solute + solvent), not just the water. In Example 2 many students divide 5 by 45 and get the wrong answer. Always add first.

Did you know?

The saline drip in hospitals is a **0.9%** salt solution, almost the same saltiness as your blood. A 500 g bag holds only 4.5 g of salt. Oral rehydration solution (ORS) uses the same idea and has saved millions of children from dehydration.

7 One-page cheat sheet

- ✓ **Solute** dissolves. **Solvent** dissolves it. Together they make a **solution**. A solution is a homogeneous mixture.
- ✓ A true solution is clear, stable, and its particles cannot be filtered out. Colloids show the Tyndall effect. Suspensions settle.
- ✓ Solutions can be solid, liquid or gas. Examples: sweet tea, soda water, air, brass.
- ✓ **Solubility** = maximum grams of solute in 100 g solvent at a given temperature. Unsaturated, saturated and supersaturated are three states.
- ✓ Solids usually dissolve more when hot. Gases dissolve less when hot but more under pressure.
- ✓ Stirring and powdering speed up dissolving. They do not change the limit.
- ✓ **Mass %** = $(\text{solute} \div \text{solution}) \times 100$.

8 Test yourself

- Q1. Name the solute and the solvent in: (a) tincture of iodine (b) soda water (c) brass.
- Q2. Why does stirring make sugar dissolve faster, and does it change the maximum amount that can dissolve?
- Q3. 30 g of sugar is dissolved in 120 g of water. Find the mass percentage of the solution.
- Q4. Using Fig 4, how many grams of KNO_3 dissolve in 100 g of water at 40 °C, roughly?
- Q5. You shine a torch through a glass of milk-water and see a bright beam. What kind of mixture is it? Give one more example.
- Q6. Why does a warm soft drink lose its fizz sooner than a cold one?
- Q7. A student adds sugar until some stays undissolved at the bottom. Is the solution saturated? Explain.
- Q8. How many grams of salt are there in 500 g of a 0.9% saline solution?

Peek only after trying!

Answers. 1) (a) iodine, alcohol (b) carbon dioxide, water (c) zinc, copper. 2) Stirring brings fresh water to the sugar so it dissolves faster, but the maximum stays the same at a fixed temperature. 3) Solution = 150 g, so $30 \div 150 \times 100 = 20\%$. 4) About 64 g. 5) A colloid (Tyndall effect). Another example: fog or ink. 6) Gases dissolve less in warm liquid, so the carbon dioxide escapes faster. 7) Yes, it has dissolved the maximum at that temperature. 8) 4.5 g.



A last word from your teacher

Sugar did not vanish. It just became too small for our eyes. Chemistry is full of such hidden worlds, and every one of them starts with someone asking 'where did it go?'. Keep asking. **Keep exploring!** - Surajit Sir