Particles Have Spaces Between Them

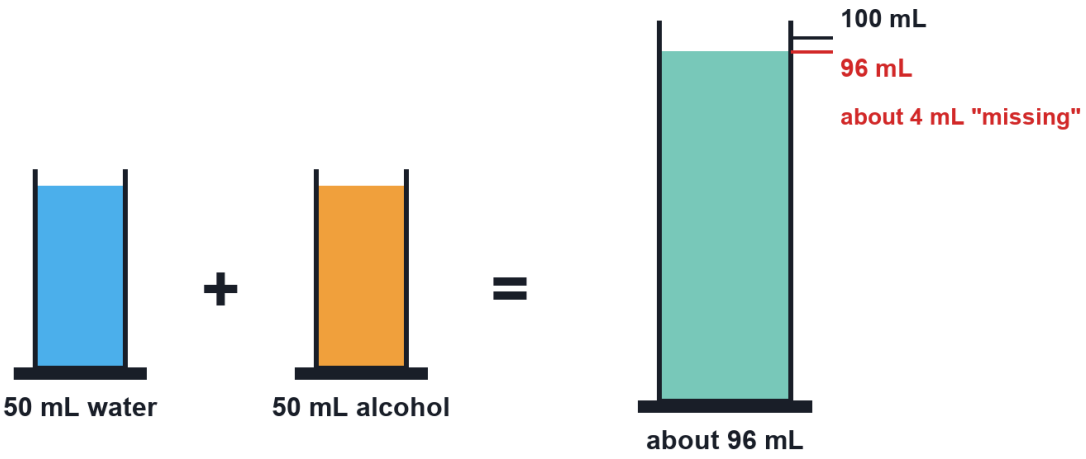
Class 9 Chemistry · Chapter: Matter in Our Surroundings
🎬 **Video explanation (PrayogX reel):** https://www.instagram.com/reel/DfCs6LglLWP/

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1. The puzzle

Pour **50 mL of water** and **50 mL of alcohol** (ethanol) into one measuring cylinder. You expect 100 mL, but you get only **about 96 mL**. Nothing spilled. Where did the "missing" volume go? The answer: **the particles of matter have spaces between them**, and some particles fit into the spaces between others.

50 mL water + 50 mL alcohol = about 96 mL (not 100 mL)



2. Key definitions

Term	Meaning
Matter	Anything that has mass and occupies space (volume).
Particles of matter	The extremely small units (atoms/molecules) that all matter is made of.
Interparticle (intermolecular) space	The empty space between the particles of matter.
Dissolving	The process in which particles of a solute (e.g. sugar) spread out between the particles

Term	Meaning
	of a solvent (e.g. water).
Solution	A uniform mixture formed when a solute dissolves in a solvent.

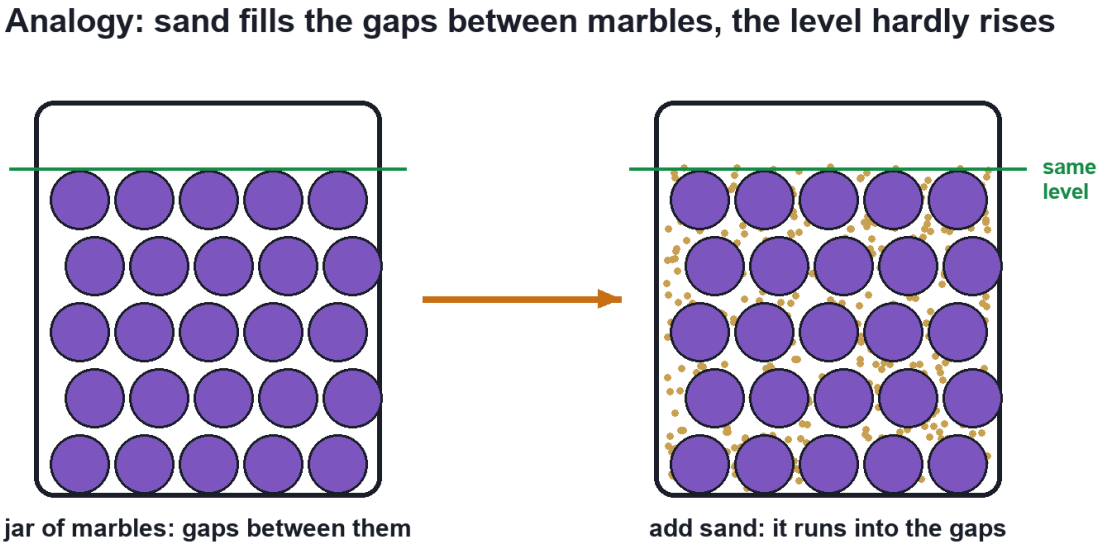
3. Characteristics of particles of matter (NCERT)

1. **Particles of matter have space between them.** (this note)
2. Particles of matter are continuously moving (they have kinetic energy).
3. Particles of matter attract each other (force of attraction).

4. Step-by-step explanation

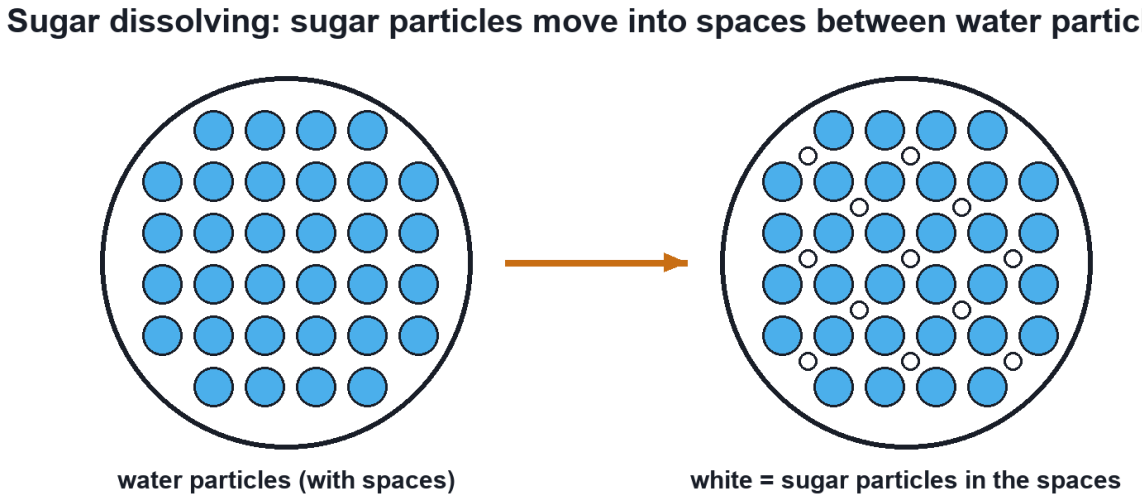
Step 1. All matter is made of tiny particles, too small to see even with an ordinary microscope.
Step 2. These particles are not packed with zero gaps; there is **empty space** between them.
Step 3. When two substances mix, the particles of one can occupy the spaces between the particles of the other.
Step 4. So the total volume can be **less than** the sum of the separate volumes (water + alcohol), or a solid can dissolve with **almost no rise in level** (sugar in water).

5. The marbles-and-sand analogy



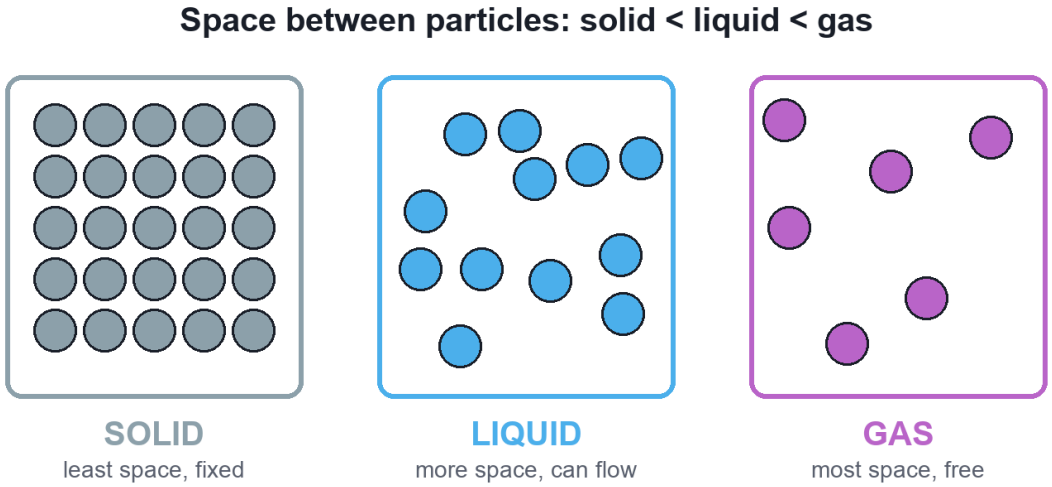
A jar full of marbles still has gaps between the marbles. Pour in sand: the sand runs into the gaps and the level hardly rises. Big alcohol particles and small water particles behave in a similar way: some particles slip into the spaces between others, so the mixture takes up less room.
Note: the forces of attraction between water and alcohol particles also pull them closer; at Class 9 level the key idea is that particles have spaces between them.

6. Sugar (or salt) dissolving in water: NCERT activity



1. Take a 100 mL beaker, fill half with water and mark the level.
2. Add some sugar or salt and stir with a glass rod till it dissolves.
3. Observe: the sugar disappears and the water level **hardly changes**.
4. **Conclusion:** the sugar particles get into the spaces between the water particles.

7. Space between particles in the three states



Property	Solid	Liquid	Gas
Space between particles	Least	More	Maximum
Force of attraction	Strongest	Moderate	Weakest
Compressibility	Negligible	Very little	Highly compressible

Property	Solid	Liquid	Gas
Example	Ice, iron	Water, milk	Air, LPG (compressed into cylinders)

Rule: interparticle space increases from solid → liquid → gas. That is why gases can be compressed into a small cylinder (CNG, LPG, oxygen cylinders).

8. Everyday examples

- Sugar in tea "disappears" but the tea becomes sweet throughout.
- Potassium permanganate crystals colour a whole beaker of water; even after repeated dilution the colour is visible (very many tiny particles spreading through the spaces).
- The smell of incense or perfume spreads through a room (gas particles move through the large spaces in air).
- A syringe full of air can be pushed in a lot; one full of water hardly at all.

9. Solved examples

Solved example 1. 50 mL of water is mixed with 50 mL of ethanol and the final volume is 96.4 mL. Find the decrease in volume and the percentage decrease.
Solution: Expected volume = 100 mL. Decrease = 100 − 96.4 = **3.6 mL**. Percentage decrease = (3.6 ÷ 100) × 100 = **3.6 %**. Reason: particles have spaces between them, and some particles fit into these spaces.
Solved example 2. Why does the water level not rise noticeably when a spoon of salt is dissolved in a glass of water?
Solution: The salt particles move into the spaces between the water particles, so they take up very little extra volume.

10. Key takeaways

- Matter is made of particles with **spaces between them**.
- When substances mix or dissolve, particles of one occupy the spaces between particles of the other.
- Water + alcohol: total volume less than the sum (50 + 50 ≈ 96 mL).
- Space between particles: **solid < liquid < gas**; gases are the most compressible.

Practice questions (CBSE style)

Q1 (MCQ). When sugar dissolves in water, the level of water:
(a) rises a lot (b) hardly changes (c) falls sharply (d) doubles
Q2 (MCQ). Interparticle spaces are maximum in:
(a) iron (b) water (c) ice (d) air
Q3 (Short answer, 2 marks). Describe an activity to show that particles of matter have spaces between them.

Q4 (Short answer, 2 marks). Why can gases be compressed easily but solids cannot?
Q5 (Numerical, 2 marks). 100 mL of water and 100 mL of ethanol are mixed and the final volume is 193 mL. Find the decrease in volume and the percentage decrease.
Q6 (Application, 3 marks). A student says, "When salt dissolves in water, the salt is destroyed." Correct the student using the idea of particles and spaces.
Q7 (Diagram based, 3 marks). Draw the arrangement of particles in a solid, a liquid and a gas. Label which has the largest space between particles.
Q8 (Case based, 4 marks). A jar is full of marbles. Riya pours fine sand into it and shakes it. Almost all the sand goes in, but the top level hardly changes.
(a) Where did the sand go? (1)
(b) What do the marbles and sand represent in matter? (1)
(c) Which observation with liquids is explained by this model? (1)
(d) State the property of particles of matter shown. (1)

Answer key with worked solutions

A1. (b) hardly changes.
A2. (d) air (a gas).
A3. Take a beaker half full of water and mark the level. Dissolve a spoon of sugar or salt by stirring. The solid disappears and the level hardly changes, showing that the sugar/salt particles have gone into the spaces between the water particles.
A4. In gases the particles are very far apart (large spaces) and forces of attraction are weak, so they can be pushed closer. In solids the particles are closely packed with very little space, so they cannot be compressed.
A5. Expected = 200 mL. Decrease = 200 − 193 = **7 mL**. Percentage decrease = (7 ÷ 200) × 100 = **3.5 %**.
A6. The salt is not destroyed. Its particles separate and spread into the spaces between the water particles, so we cannot see them. The water tastes salty and the salt can be recovered by evaporating the water.
A7. Solid: particles closely packed in a regular pattern; liquid: particles close but irregular with small gaps; gas: particles far apart. The **gas** has the largest spaces (as in the diagram in Section 7).
A8. (a) Into the gaps between the marbles. (b) Marbles = larger particles, sand = smaller particles of matter. (c) Mixing 50 mL water and 50 mL alcohol gives less than 100 mL (or sugar dissolving with little change in level). (d) Particles of matter have spaces between them.