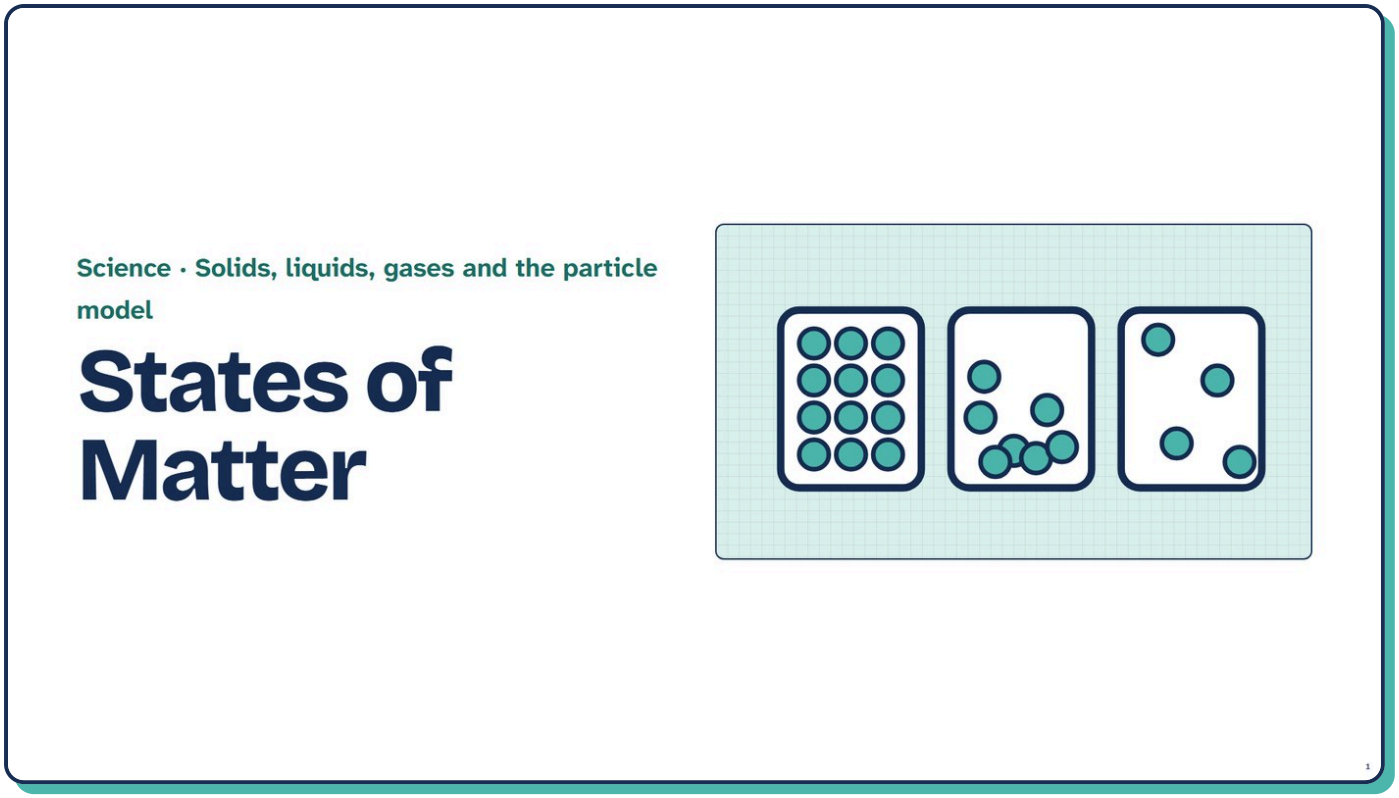

States of Matter

Teacher notes

Put an ice cube on a saucer at the front of the room at the start of the lesson. Ask: what will this look like in 40 minutes, and where will the water have gone by tomorrow? Keep the predictions on the board and return to them at the end.

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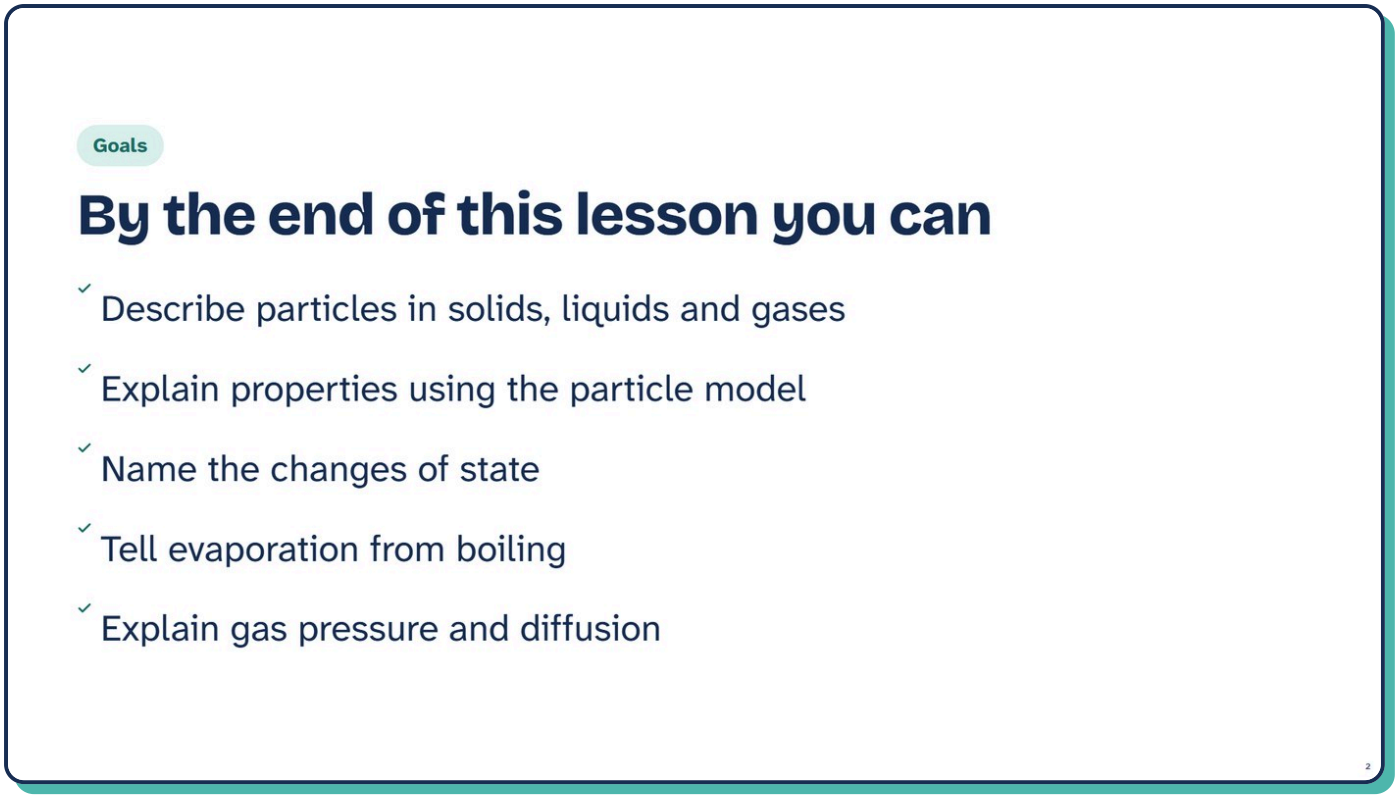

By the end of this lesson you can

Teacher notes

Read the objectives aloud. Ask students to draw three empty boxes labelled solid, liquid and gas; they will fill them with particle drawings during the lesson.

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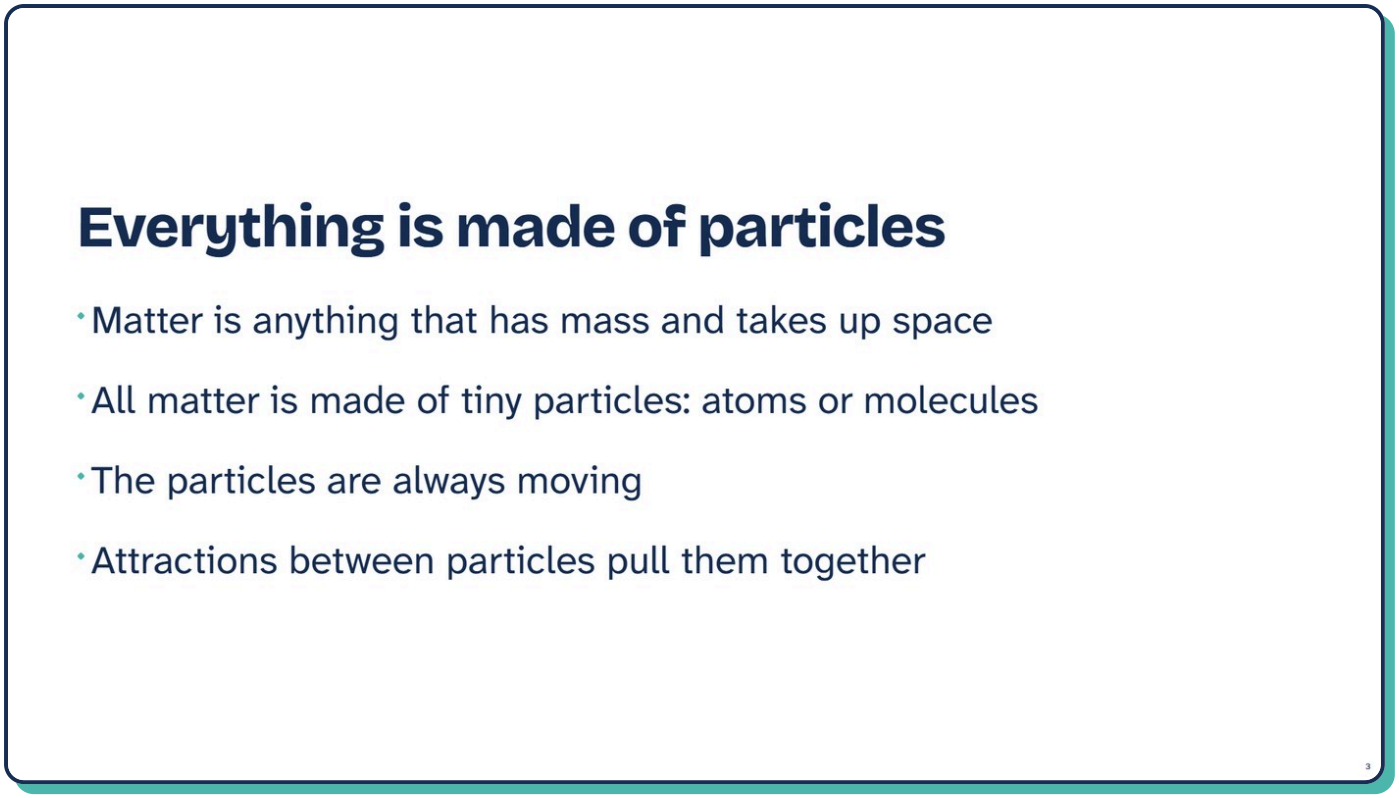

Everything is made of particles

Teacher notes

This is the particle model. It is a model, which means a simplified picture that helps us explain and predict. We draw particles as circles, but real atoms and molecules are far too small to see even with a school microscope.

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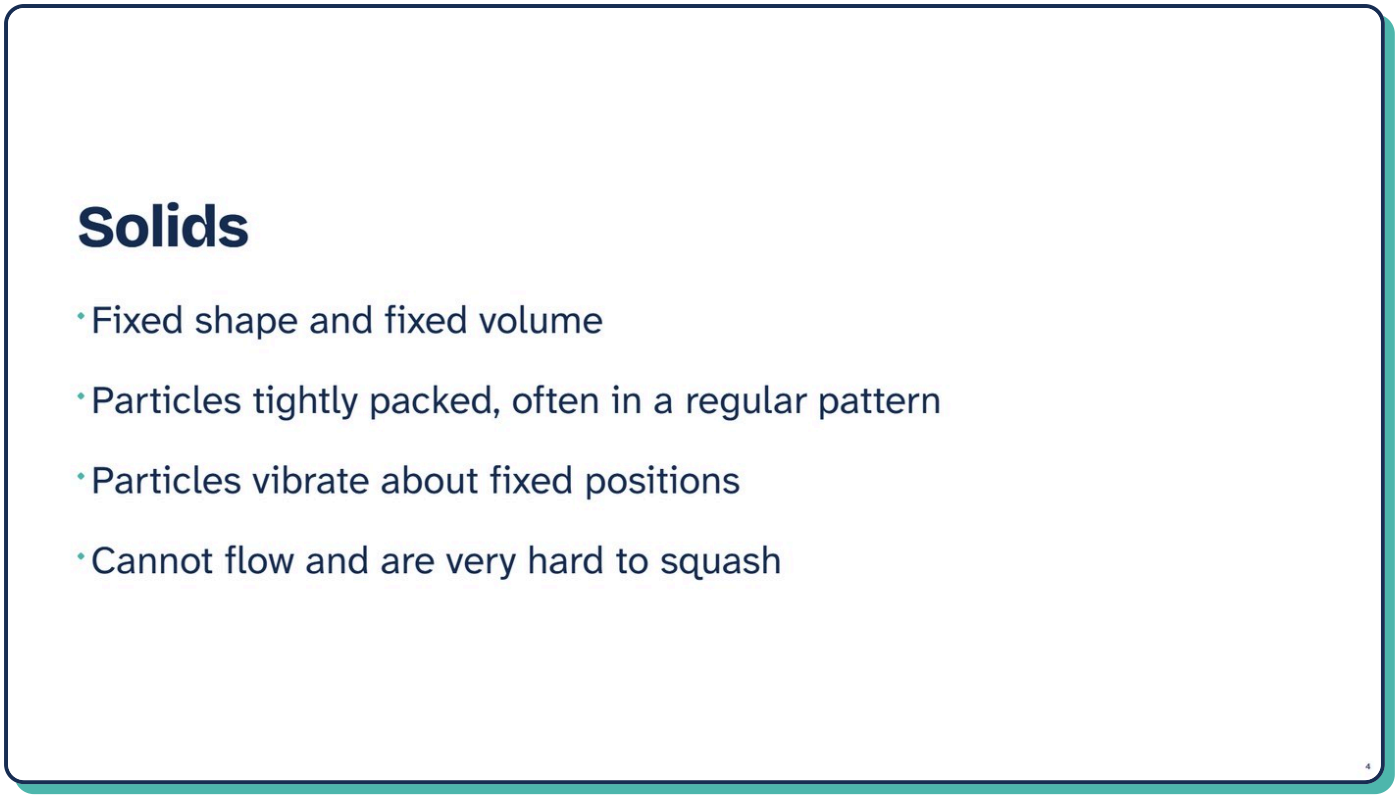

Solids

Teacher notes

Ask students to draw a solid in their first box: circles touching, in neat rows. Ask them to add small zigzag lines to show vibration. Link each property to the picture: no gaps, so it cannot be squashed; fixed positions, so it keeps its shape.

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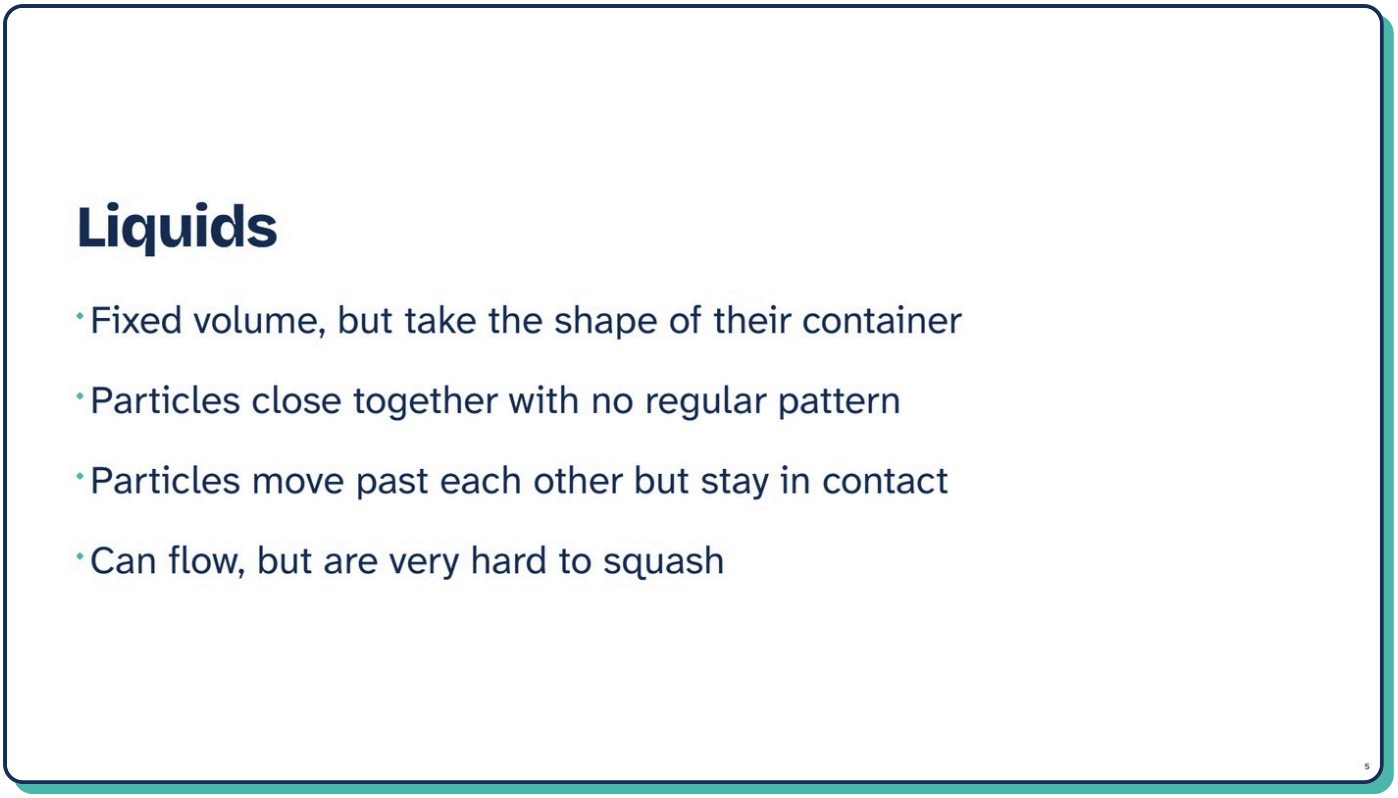

Liquids

Teacher notes

In the second box, students draw particles still touching but jumbled, with arrows showing them sliding past each other. Common error: drawing liquid particles far apart. Remind them that liquids are almost as hard to squash as solids, so the particles must still be close.

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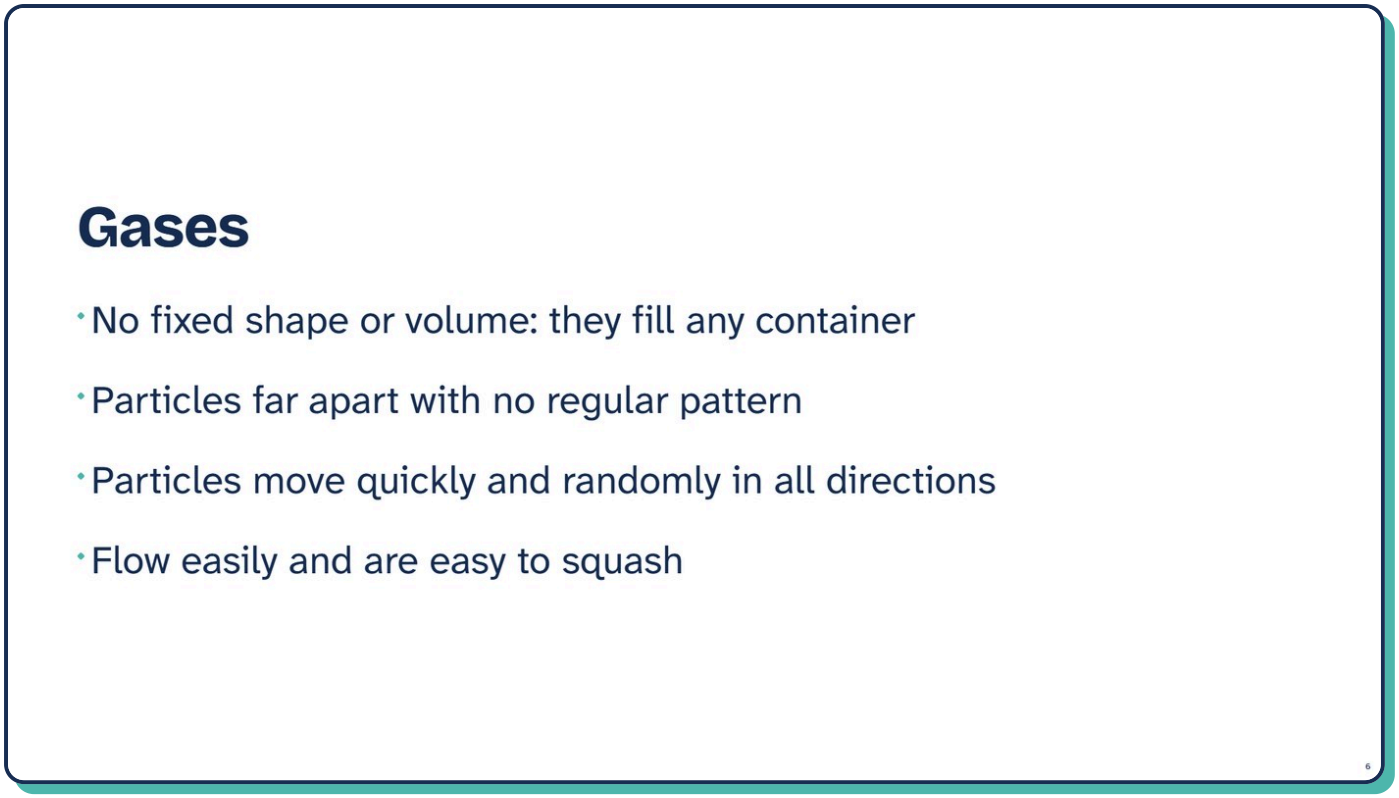

Gases

Teacher notes

In the third box, students draw a few widely spaced particles with long arrows. The space between gas particles is empty: there is no air between the particles of air. Squeezing a sealed syringe of air works because there is space to push the particles into.

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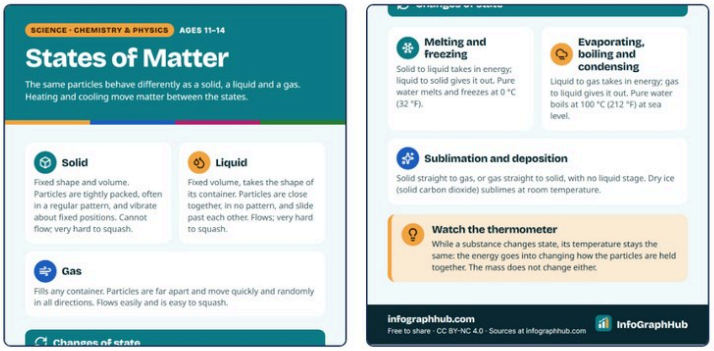
Solids, liquids and gases compared

- Same particles, different spacing and movement
- Changes of state move between the three

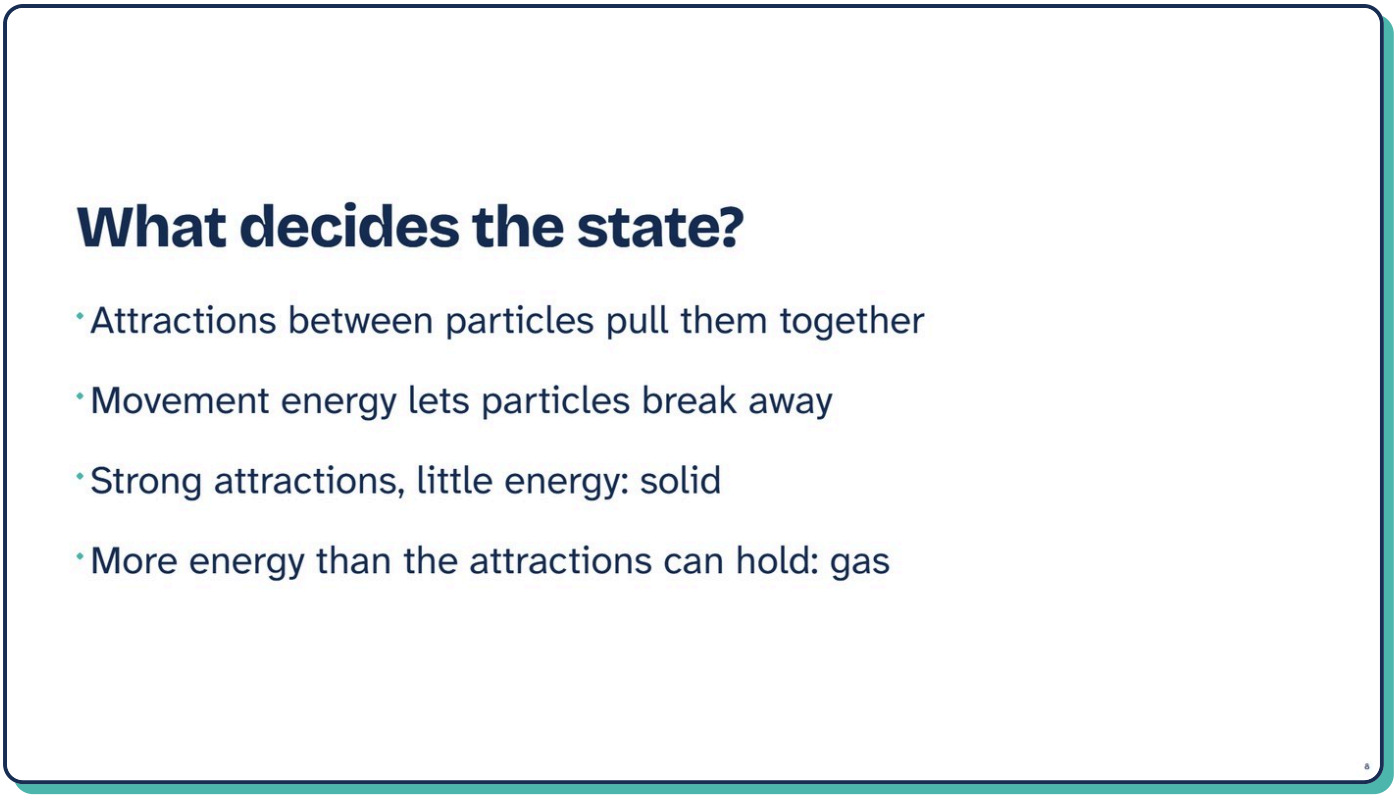


Poster: States of Matter: Solids, Liquids and Gases in the Particle Model

Solids, liquids and gases compared

Teacher notes

Use the poster to check students' three drawings. Ask them to correct any box that does not match. Point out that the particles themselves are the same in all three states: only their spacing, arrangement and movement change.



What decides the state?

Teacher notes

Use a tug-of-war image: attractions pull particles together while movement energy pulls them apart. Heating gives particles more movement energy, so a solid can become a liquid and then a gas. Cooling does the opposite.

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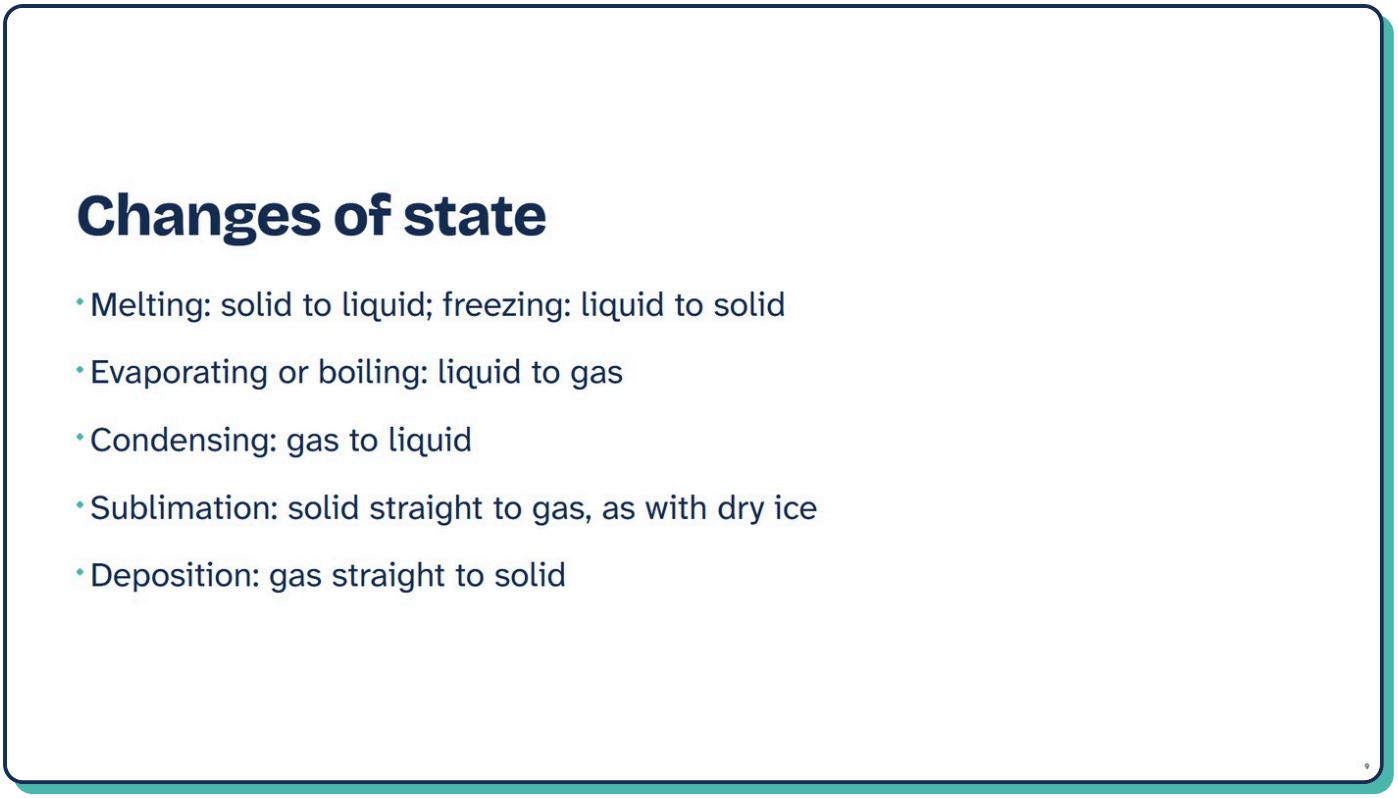

Changes of state

Teacher notes

Draw a triangle on the board with solid, liquid and gas at the corners and add an arrow for each change. Dry ice is solid carbon dioxide; at room temperature and normal pressure it turns straight into a gas. Changes of state are physical changes: the substance is still the same substance, and its mass does not change.

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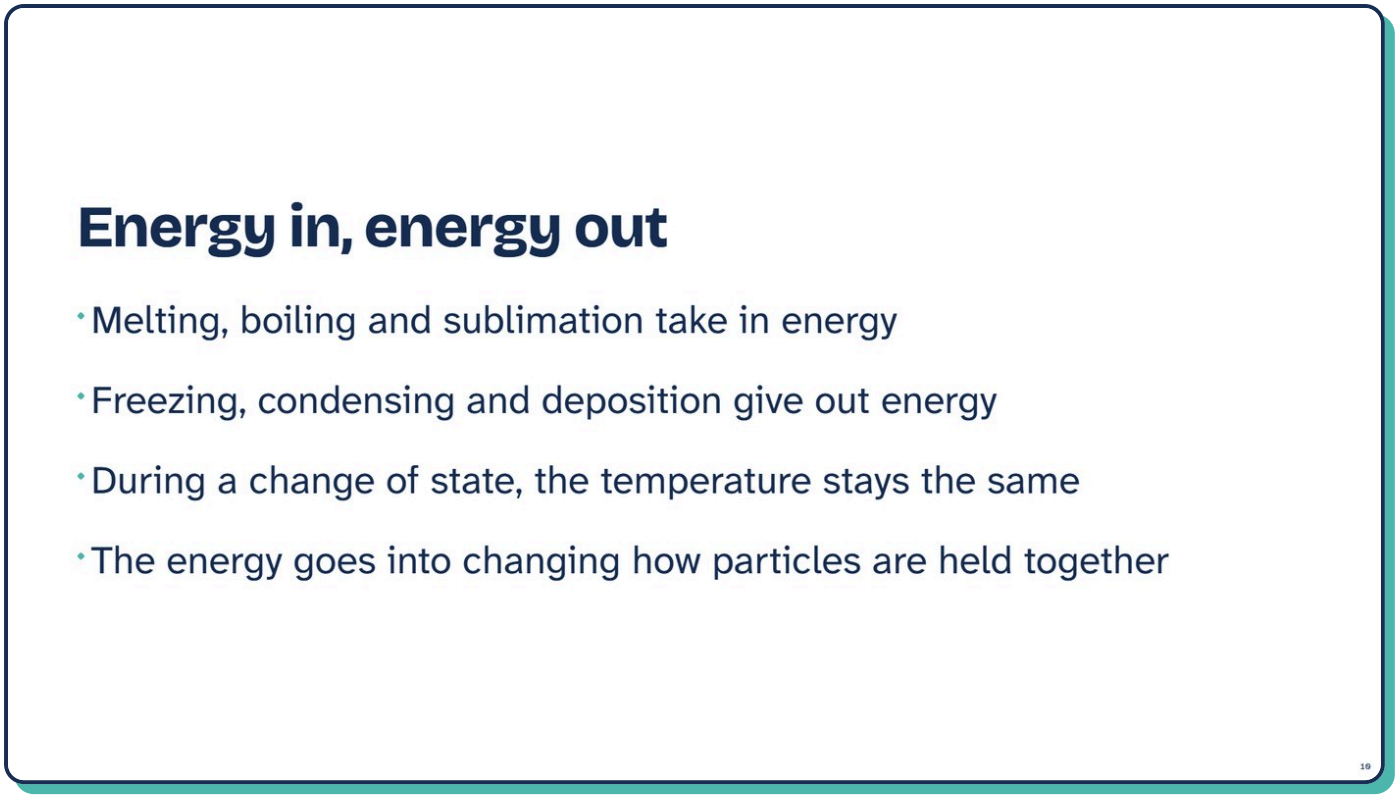
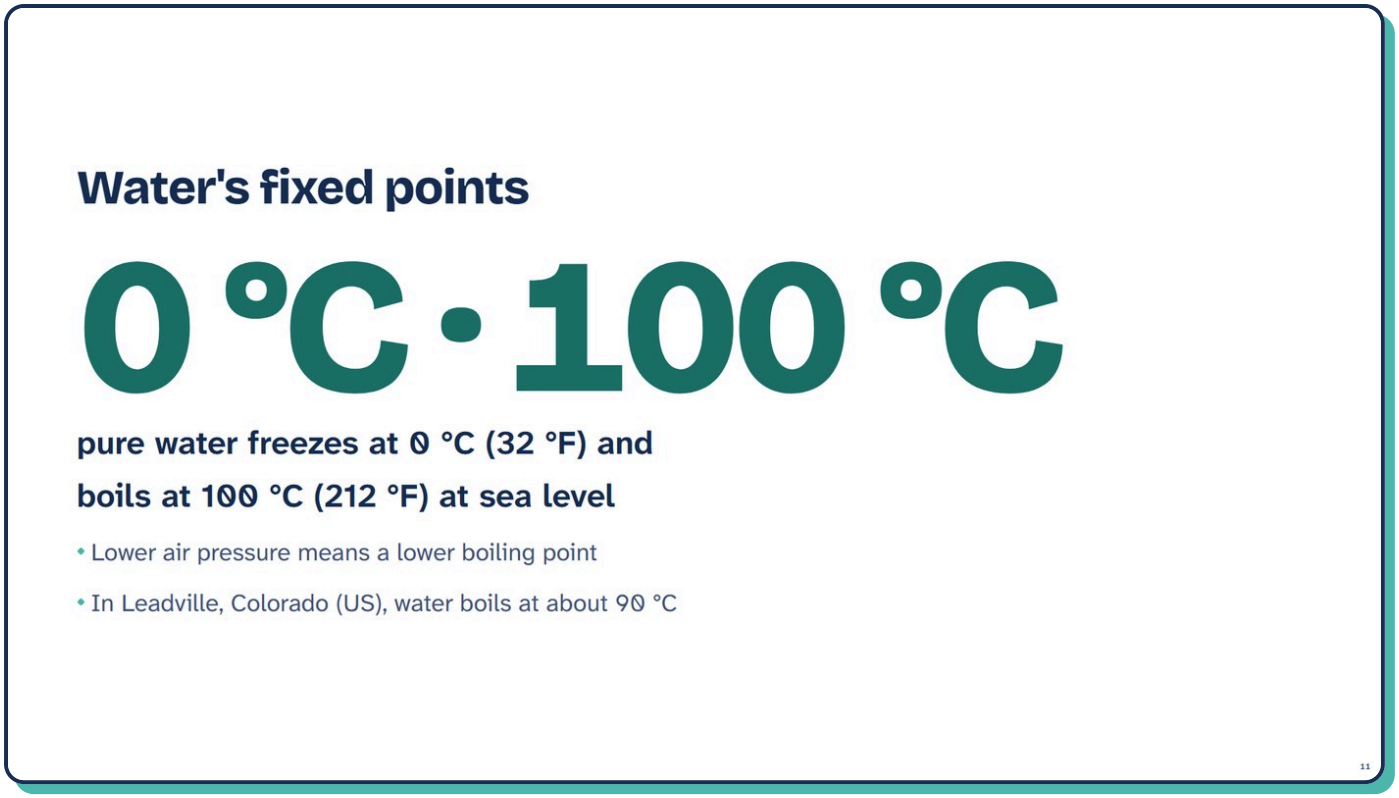


Energy in, energy out

Teacher notes

Sketch a heating curve: temperature rises, then a flat section while the solid melts, then rises again, then another flat section while the liquid boils. Students are often surprised that a pan of boiling water stays at the same temperature however hard you heat it.



Water's fixed points

Teacher notes

Leadville is a mountain town in the Rocky Mountains where the air pressure is about 68 kPa, roughly two-thirds of the 101.3 kPa at sea level, so water boils at around 90 °C (194 °F). The boiling point is the temperature at which the liquid's vapour pressure equals the pressure of the air above it.

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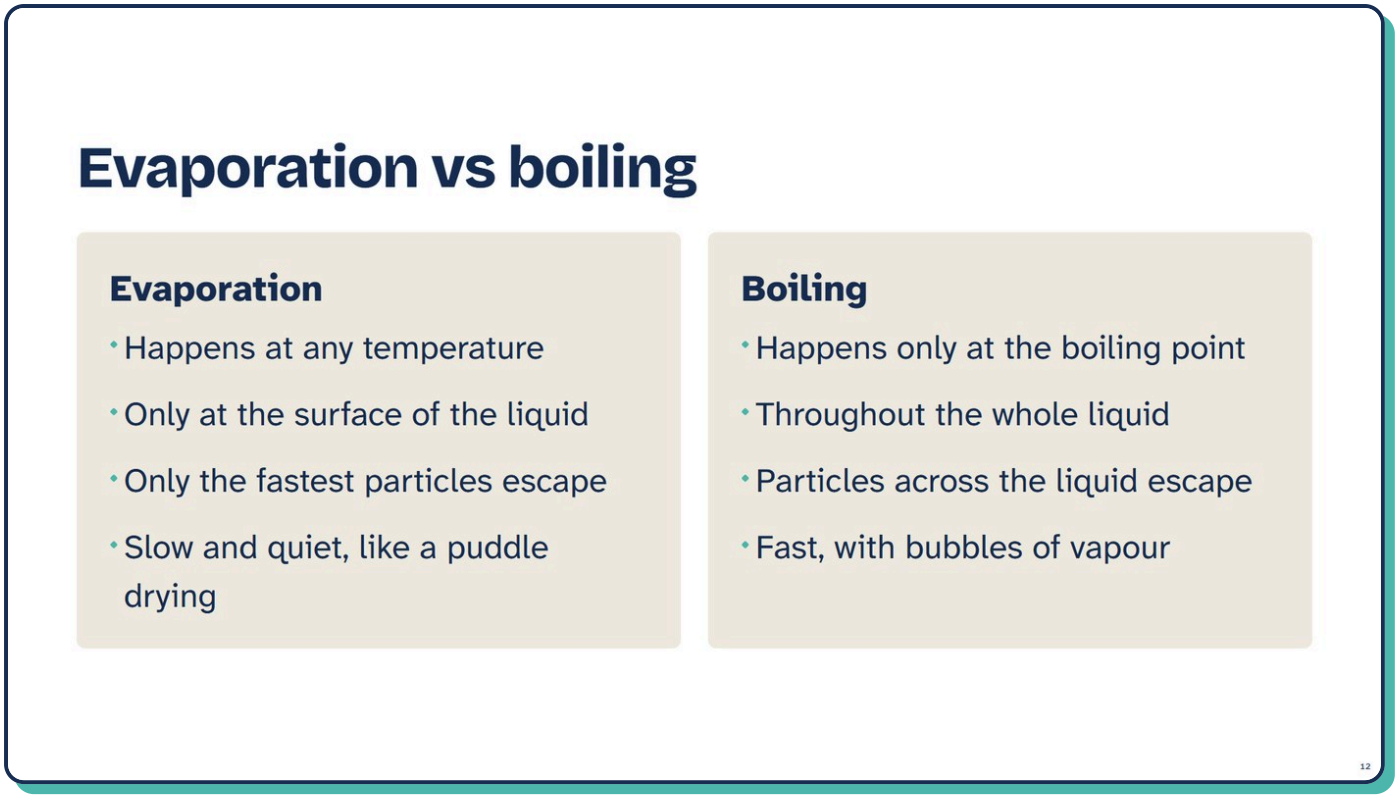

Evaporation vs boiling

Teacher notes

Ask students where the puddle goes on a sunny day without ever reaching 100 °C. Only the fastest-moving particles at the surface have enough energy to break away, so evaporation is slow but happens at any temperature. Warmer liquids evaporate faster because more particles have enough energy.

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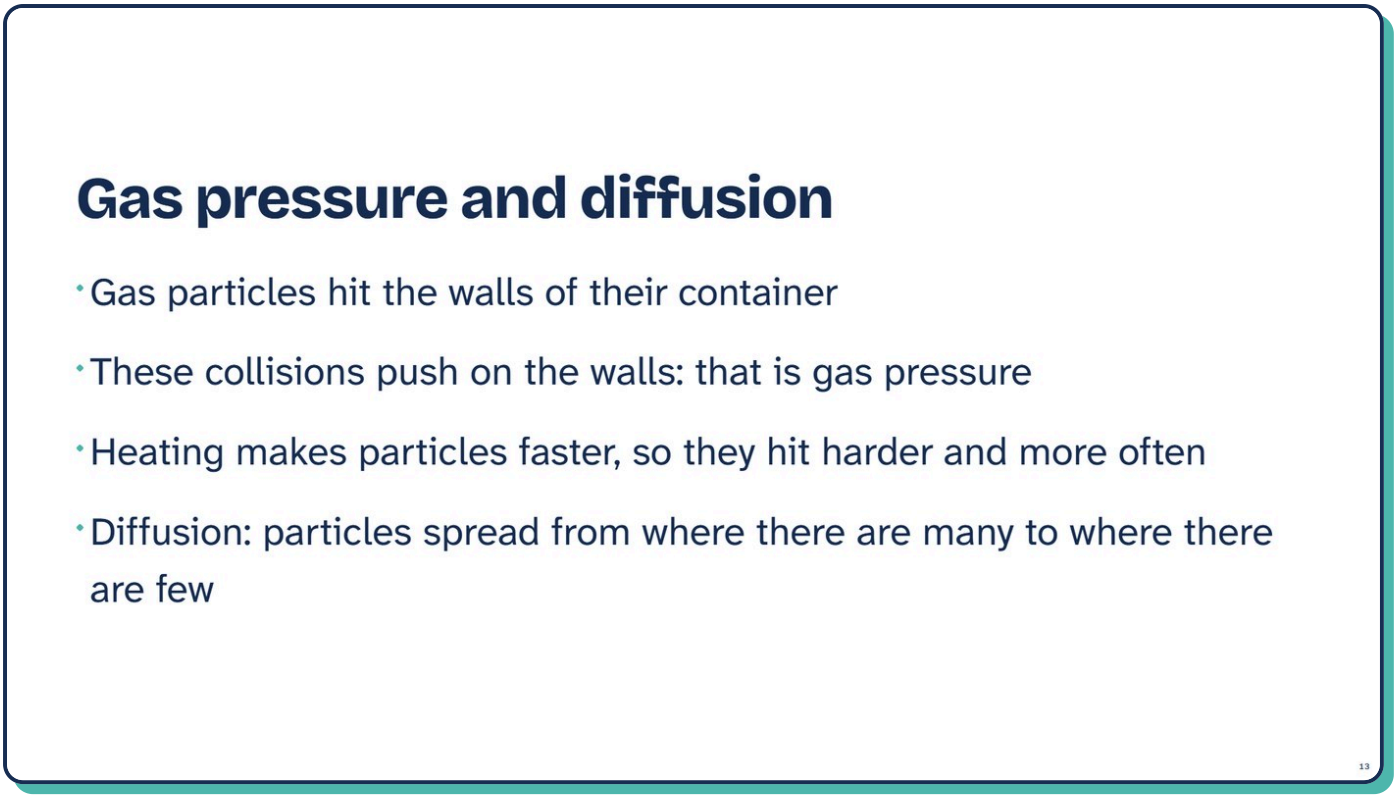

Gas pressure and diffusion

Teacher notes

Demonstrate diffusion by spraying air freshener or opening a bottle of perfume at the front and asking students to raise a hand when they smell it. Gases diffuse quickly because their particles move fast and there is lots of space between them. Ask why a sealed bag of crisps swells on a warm day.

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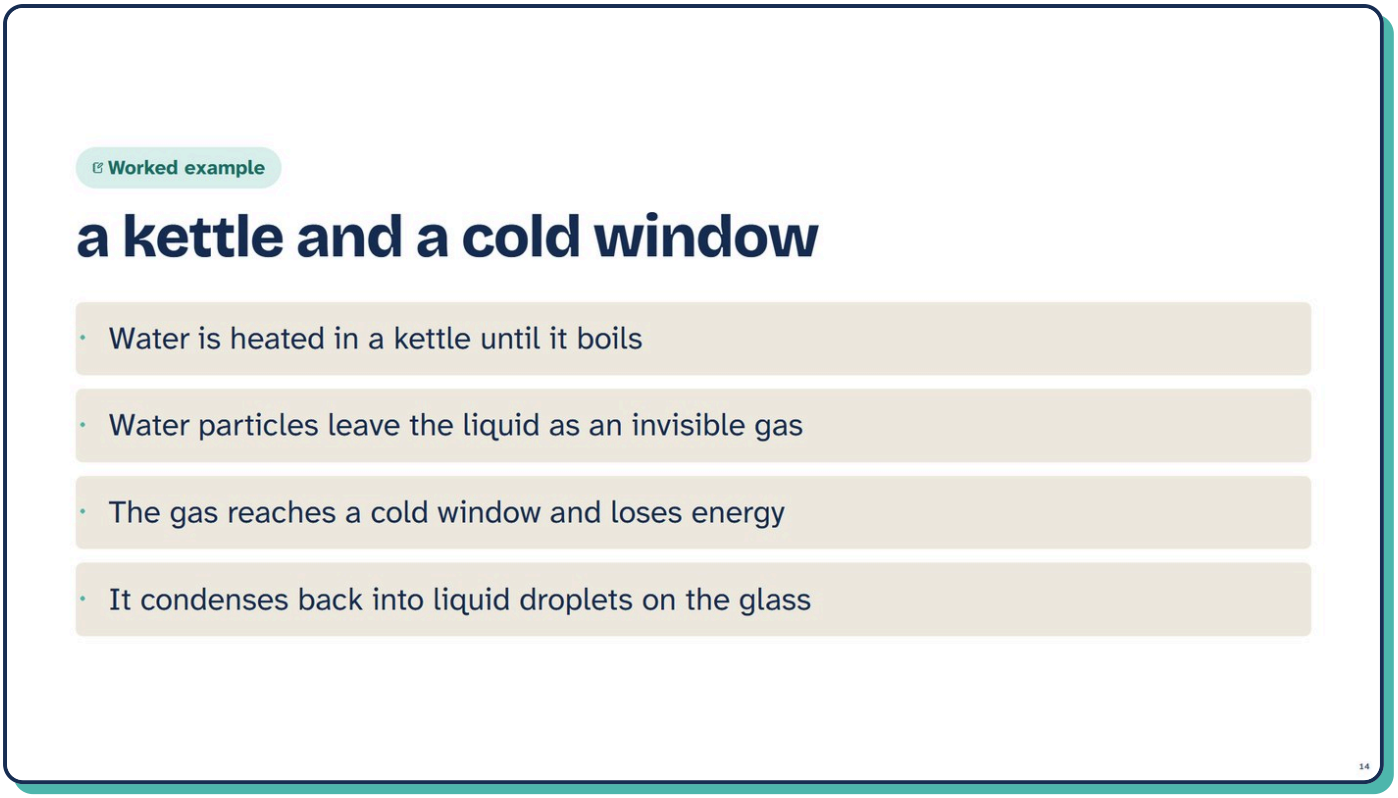

Example: a kettle and a cold window

Teacher notes

Ask students to name each change of state and say whether energy is taken in or given out at each step. Then ask them to draw particle diagrams for the water in the kettle, in the air and on the window. Kettles get hot: keep any real demonstration at a safe distance.

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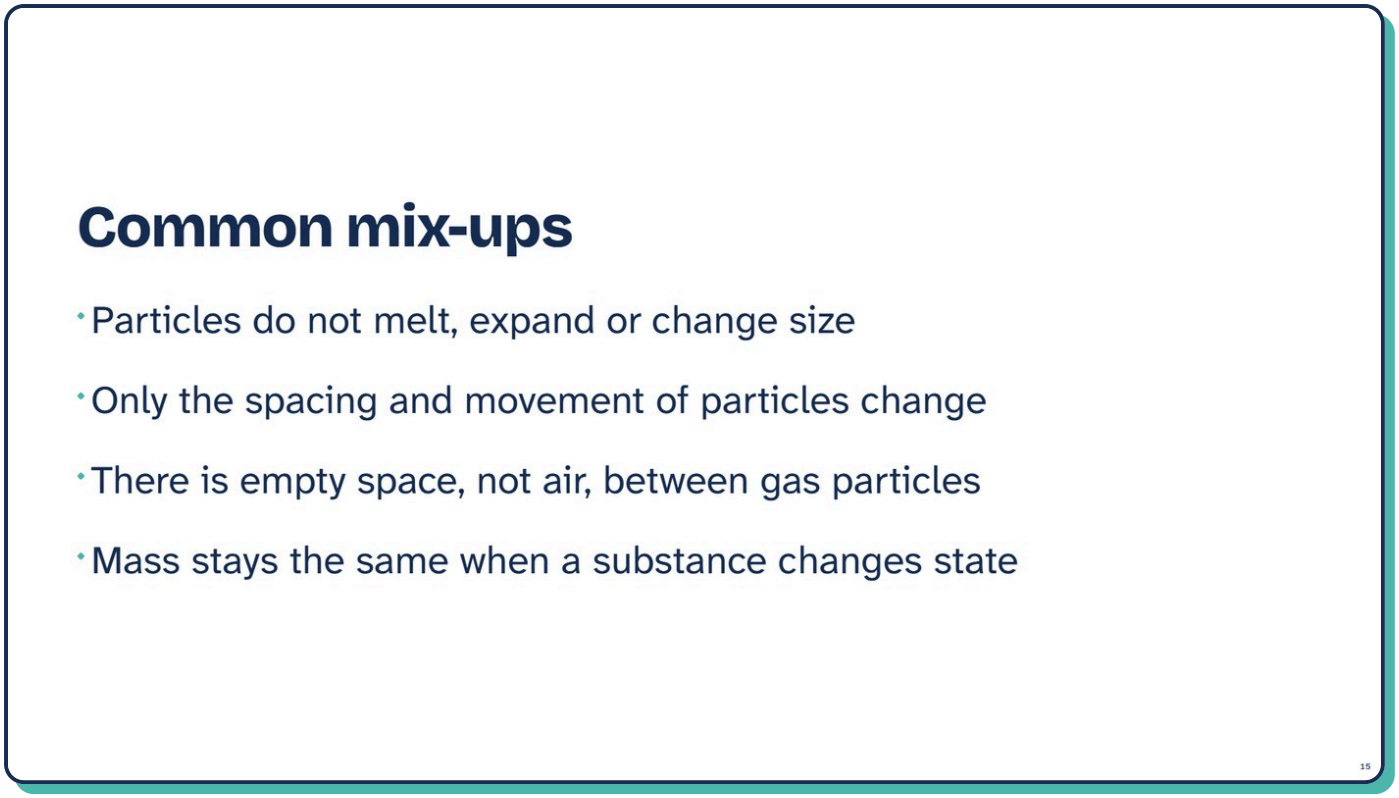

Common mix-ups

Teacher notes

Ask students to vote true or false before revealing each bullet. A sealed bag of ice that melts has exactly the same mass afterwards; you can show this on a balance. When something expands on heating, it is because the particles move more and spread out, not because each particle grows.

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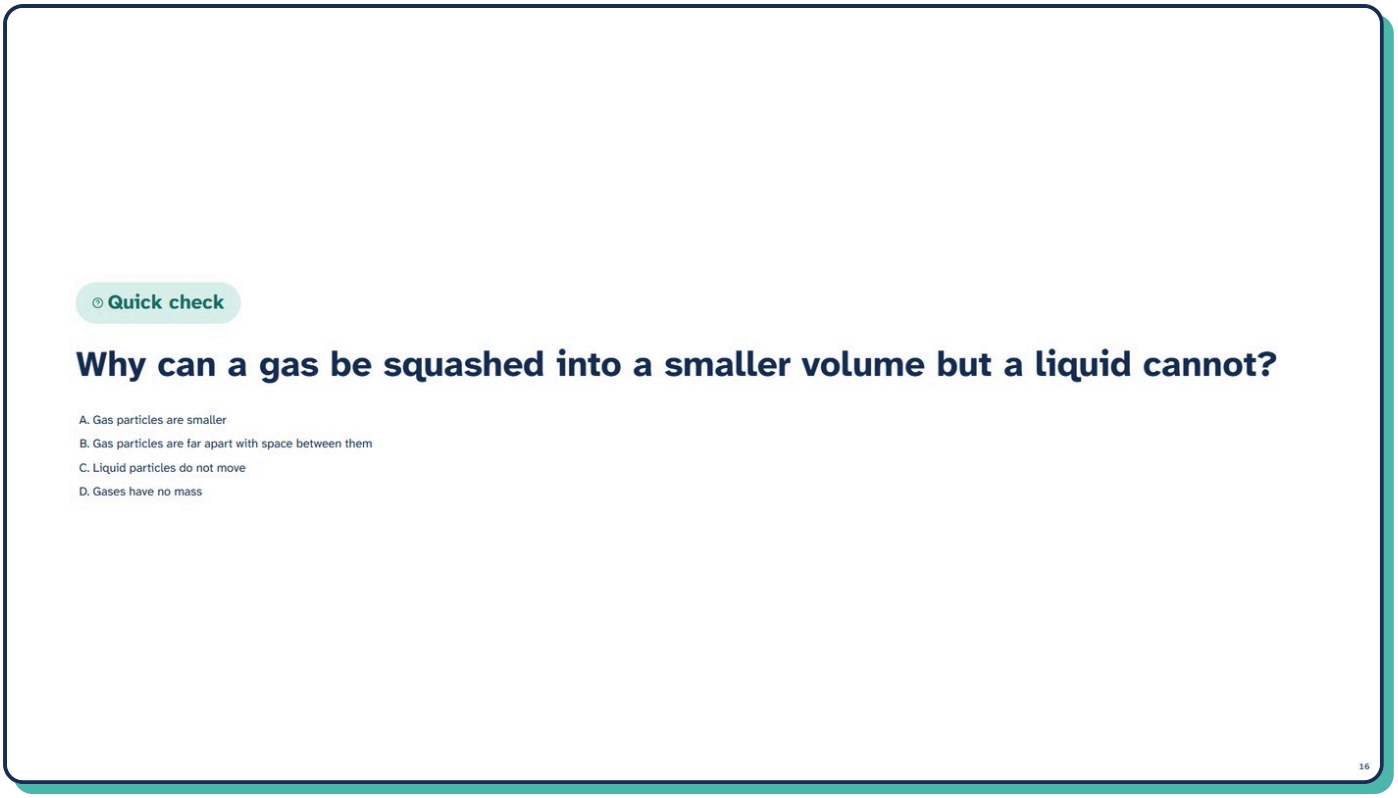
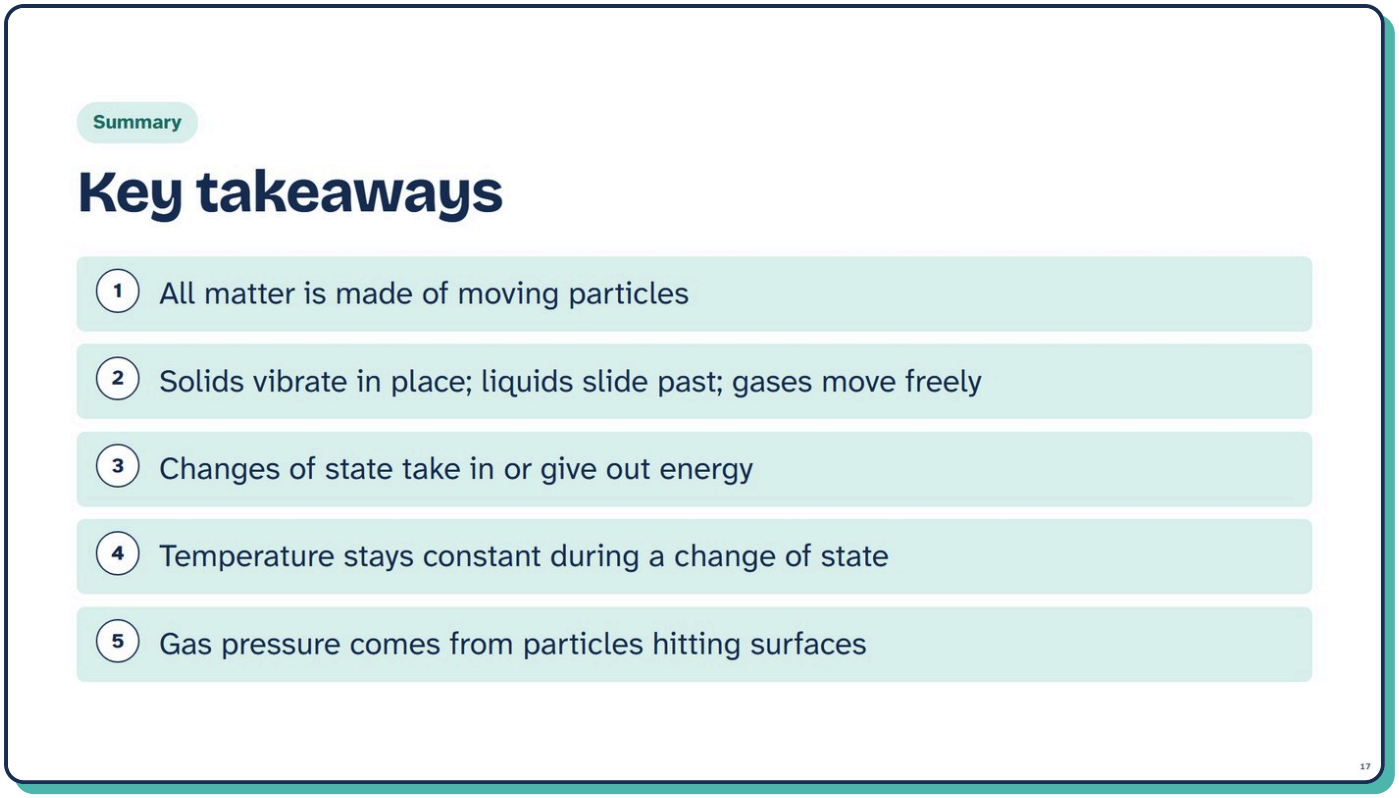


Quick check

Teacher notes

Answer: gas particles are far apart. Liquid particles are already touching, so there is almost no space to push them into. Use wrong answers to revisit the common mix-ups slide.



Key takeaways

Teacher notes

Look at the ice cube from the start of the lesson and ask students to explain what has happened using particles. Then move to the five-question quiz on the page. Homework idea: draw a labelled heating curve for water from −10 °C to 110 °C.

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