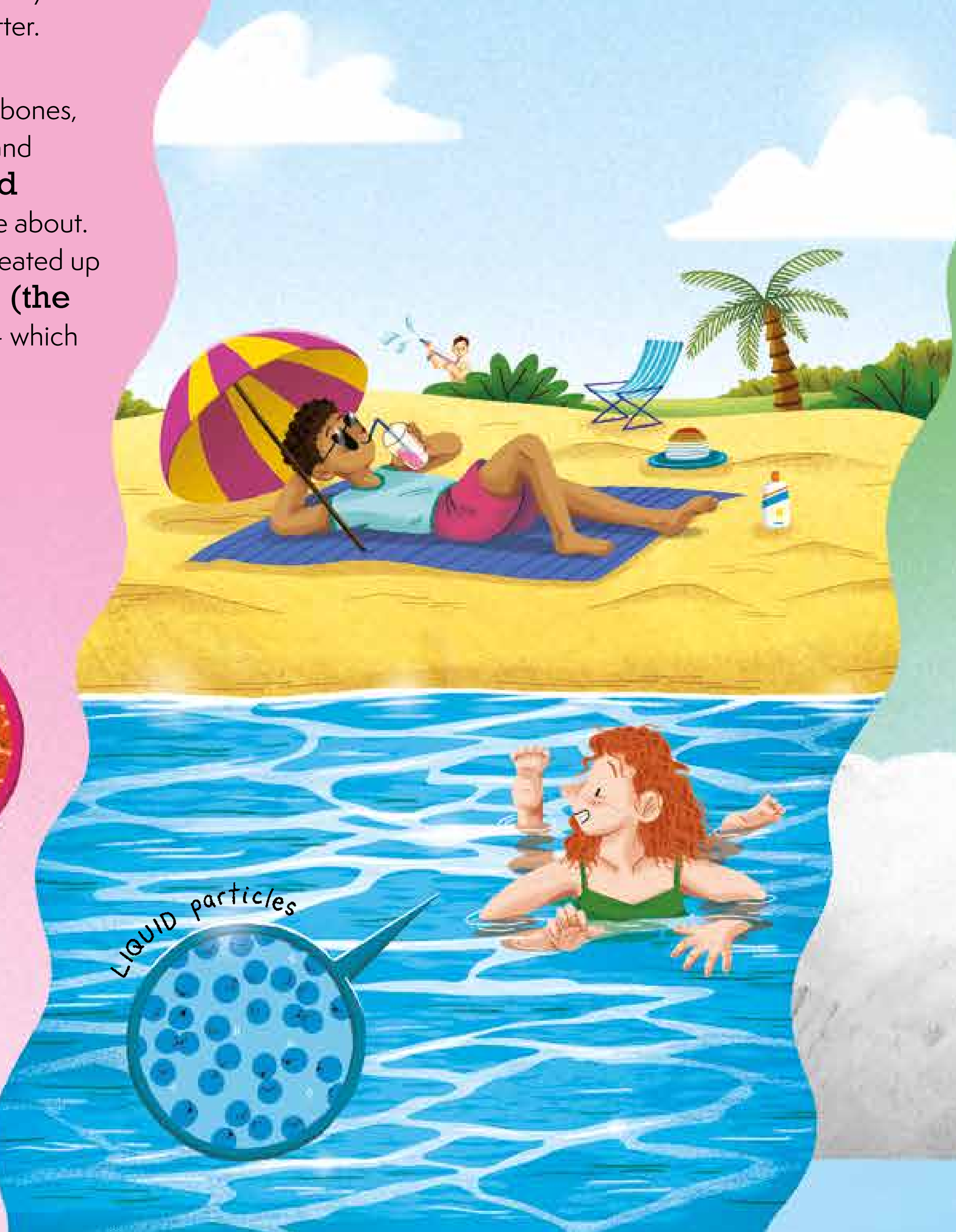
STATES OF MATTER MATTER

Solids, liquids and gases

Atoms and molecules, also called ***particles***, make up the stuff all around you, and anything made from particles is called ***matter***. From the invisible air you breathe to the pencils you draw with, from the food you munched for breakfast to the bubbles in your bath, **EVERYTHING** is made from matter.

First, we have **solids** like ice, sand, cake, bones, bricks, books and doorknobs. The atoms and molecules in solids are **closely packed together** in a pattern so they can't move about. They stay in one shape and place unless heated up or cooled down, and keep their **volume (the amount of space they take up)** – which is why you can't walk through a wall!

Next come **liquids** like water, custard, sun cream, lava, milk, wee and strawberry milkshake. Particles in liquids stay **close** to each other but are **free to move around**. They aren't stuck in a pattern and so can slide and shapeshift! If you pour cake mix from a jug into a dog-shaped cake tin, it will happily flow into a dog-shape. The **volume** has to stay the same though, so if the jug had a bigger capacity than the tin, the mix would flow over the edges.



Then there are **g a s e s** like helium, steam, oxygen and carbon dioxide.

The particles in gases **roam around freely** with no fixed pattern or fixed shape. They can spread out or squish down to fit whatever container they find themselves in as their volume can change. Not only are gases **super-shapeshifters** but they are also usually invisible.

TRY THIS

Letting off steam

1. Take a few **solid** ice cubes and put them into a pan.

2. With the help of an adult, heat the pan. The cube will melt into **liquid**. Next, the liquid will start to boil. Watch as it turns into **gas**. Eventually, there will be nothing left in the pan because the gas molecules will be invisibly drifting around the room!

WHAT HAPPENED?

Heat is an energy that gives solids a new lease of life – they vibrate until they break free of their fixed pattern – or in other words, **melt**! If you keep heating the sloshy liquid atoms, they'll start to shake and jump wildly until they whizz off into the air – or ***evaporate*** – as gas! You've just witnessed the three **states of matter** of water – see how different each one is?

WHAT'S COLDER THAN ICE?

Super-cool supercooling

Remember how atoms **fidget**? No matter how many treats you bribe atoms with or how loudly you shout at them to stay still, they simply will not stop **moving** about. What you can do, though, is change how **much** they fidget.

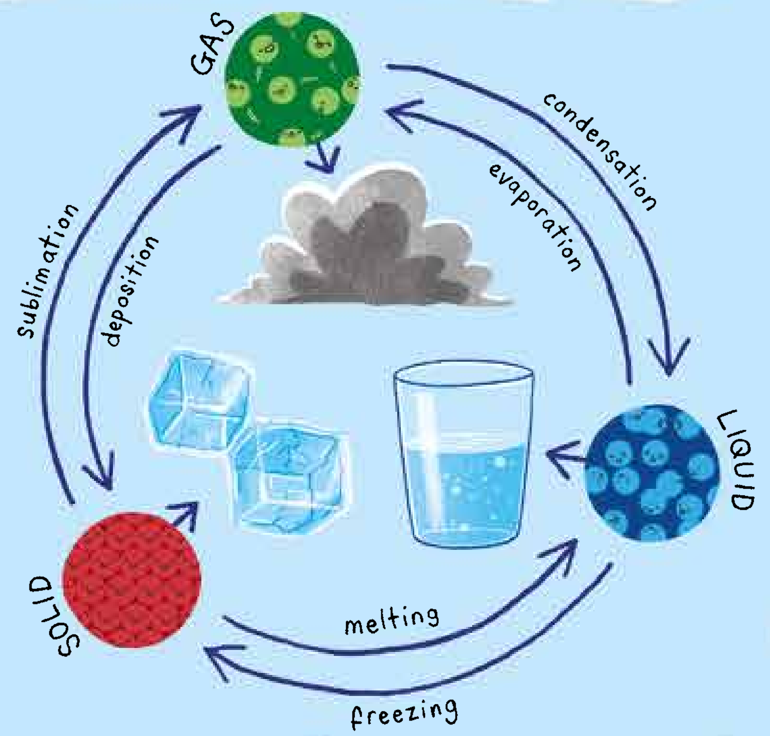
Atoms in solids have the **least** amount of energy and space to move in, so they're pretty slow and lazy. Atoms in gases are the most lively and energetic, zipping about in all directions. Atoms in liquids are in between the two.

I'll let you in on a secret: if you need to calm an atom down, just make it **chill**! Cooling an atom's temperature slows it down.

Changing states of matter

Sublimation is when a solid turns into a gas.

Deposition is when a gas turns into a solid.



Condensation is when a gas turns into a liquid.

Evaporation is when liquid turns into a gas.

FACT

Absolute zero is the coldest possible temperature anything can reach at MINUS 273°C (ice is around 0°C!). At absolute zero, atoms have the absolute LEAST energy possible. You can bet they're not much fun to be around!

Normally, liquids freeze into solids (and vice versa) at fixed temperatures. Water becomes ice at 0°C. Melted chocolate becomes solid at 35°C. But there are exceptions ... super-cool ones. When liquids behave like rebels and **don't** turn into solids at temperatures even **below** their freezing point, it's called ***supercooling***.

TRY THIS

As supercool as ice

1 Put two plastic bottles of filtered (not tap) water in a freezer. Leave them for around two and a half hours and go chill. When you take them out, the water should be supercooled and NOT frozen.

2 Hit the first bottle on a hard surface and watch the water turn to ice instantly!

3 Put an ice cube onto a plate and pour the water from the second bottle onto it. It will pour out as a liquid and magically freeze on contact with the ice cube!

WHAT HAPPENED?

In order for **ice crystals** to form from water, the water needs to:

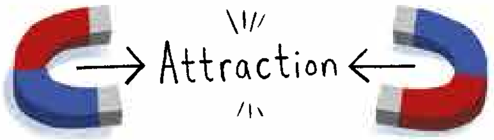
1) Be cold enough.
2) Have a special pattern of molecules that act as a base.

When the water was supercool, even though point 1 was fulfilled, it wasn't able to arrange molecules into the right **pattern** to build crystals. When you bumped the bottle, you allowed the molecules to move and find that pattern to build ice from. When you poured supercool water onto the ice cube, it was able to use the existing ice as a **starting block**.

GRIPPING, SKIDDING AND SLIPPING

The force of friction

The universe is ruled by **forces**. Forces are invisible interactions between objects, and they either have a pushing or a pulling effect. Some are contact forces, occurring when two objects touch each other, like when you kick a ball. Non-contact forces occur when an object can mysteriously push or pull another without touching it ... like when magnets connect.



There is a particular contact force that helps you to climb hills, grip spoons, write on paper and **so** much more called ***FRICTION***. It is a force that acts between two surfaces. Friction **always** acts against the direction of motion, so it has a slowing down effect, like when you press the brakes on your bike.

Sometimes friction gets a bad reputation for being a nuisance, like when it causes the soles of your shoes to wear out or gives you nasty rope burn on the climbing frame, but that's just one side of the story. If this force stopped working, you wouldn't be able to take a single step! Your legs would run but you'd be stuck slipping about in one spot. Pretty frustrating when you've got somewhere to be!

TRY THIS

Friction in action

1 Set up a sloped ramp using a smooth surface like a piece of wood, cardboard or even a big book.

2 Time how long it takes for a toy car to travel down the ramp. If you don't have a toy car, you could use a ball or a marble.

3 Put different materials over the ramp like felt, a bedsheet, plastic, toilet roll, foil, Velcro or anything else you can find. Record how long it takes the car to roll down each surface. Does it take longer to travel down surfaces that are smoother or rougher?

WHAT HAPPENED?

Friction makes surfaces stick together slightly. The amount of friction between the car's wheels and the ramp changes according to the material. Smooth surfaces, like plastic or wood, create less friction than rough ones, like Velcro or felt, allowing the car to move faster.

If you've ever played on a water slide, you'll know **all** about friction and **slipperiness**. To get that perfect **gliiiiiide**, you need a perfect combination of things. If you had water and no slide, you'd not get anywhere. And if you had the slide but no water, there would be too much friction ... **BUT** when you have water AND a slide, the liquid reduces the friction between your body and the slide, allowing you to **whoooosh** down it!