

States of Matter

National curriculum objectives (year 5):

- know that some materials will dissolve in liquid to form a solution, and describe how to recover a substance from a solution
- use knowledge of solids, liquids and gases to decide how mixtures might be separated, including through filtering, sieving and evaporating

Science in the news today

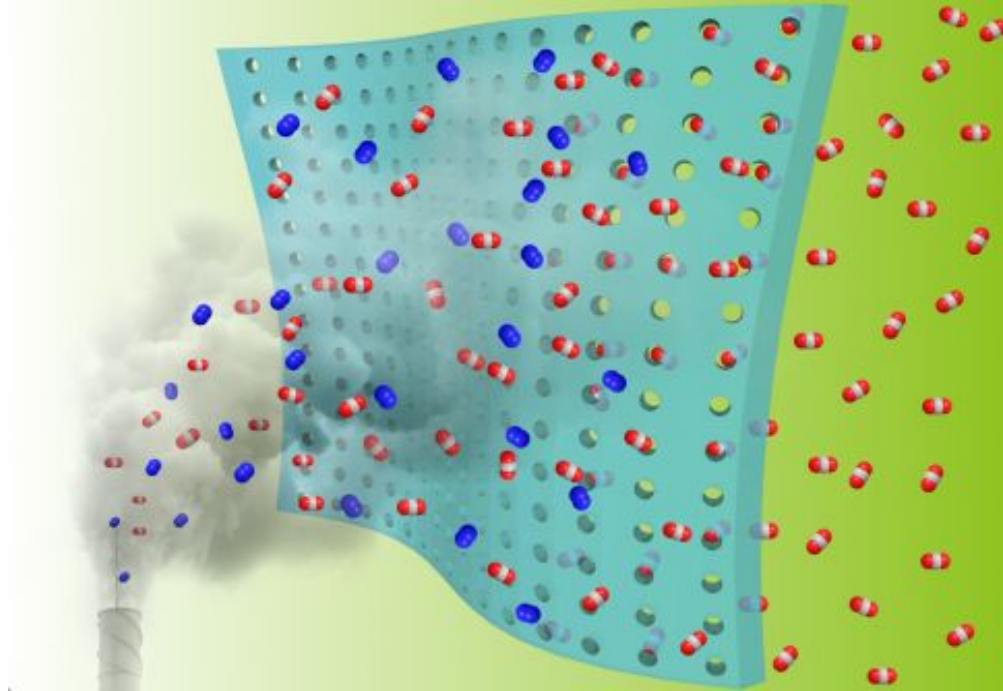
Scientists are working on a new type of filter that can selectively filter carbon dioxide (CO₂) from harmful emissions. CO₂ is a major contributor to climate change, which is causing droughts, storms, and many other problems. Currently there are different methods of 'trapping' CO₂ before it is released into the atmosphere, but these processes use a lot of energy and aren't very efficient.

When CO₂ is produced, it mixes in the air with non-harmful gases like nitrogen and oxygen. The new filter works by using a material that is attracted to CO₂ and not other gases in the air. The main material is fluoride (the same thing that's in your toothpaste!) so it's cheaper and easier than other forms of 'carbon capture' that are currently used. However, there still needs to be research on what to do with the carbon dioxide once it's been filtered, so there is still a long way to go!

Here is a picture of a new type of carbon dioxide filter

The blue square in this picture represents a filter that only allows carbon dioxide through (red), and stops harmful gases getting past (blue).

Credit: Zhenzhen Yang/University of Tennessee



What are the different states of matter?

The three separate states of matter are solids, liquids and gases. Materials in these different states will behave differently and follow different rules.

Solids



Solids stay the same shape. They can be held or cut and do not spread out.

Liquids



Liquids are free flowing. They change shape depending on the container they are in, but they always take up the same **amount** of space - their *volume* is the same.

Gases



Gases will fill the space of a container they are in, and can easily increase or decrease in volume to do so.

What is dissolving?

Dissolving is where a solid mixes with a liquid in order to form a *solution*. This means that the solid and the liquid have mixed together to form a new liquid solution. If you can still see the solid then that means it hasn't dissolved.

A good example of this is salt and sugar. These solids both dissolve in water to form a solution.



The sea is made up of a solution of salt water.

How would we recover a solid that had dissolved in a liquid?

What if you have dissolved some salt in water but you want the pure water or pure salt again?



We can do this through **evaporation**. Evaporation is a process in which a liquid is heated and turns into a gas. The solid and the liquid in the solution have different *boiling points*. This means if you heat the solution, the liquid will boil, turn into gas and leave the solid behind.

When the liquid evaporates, the solid will stay where it is. So, once all the liquid has evaporated you are left with just the solid you dissolved!

Dissolve salt
in water



Solution of salt
and water



Heat the solution so
the water evaporates



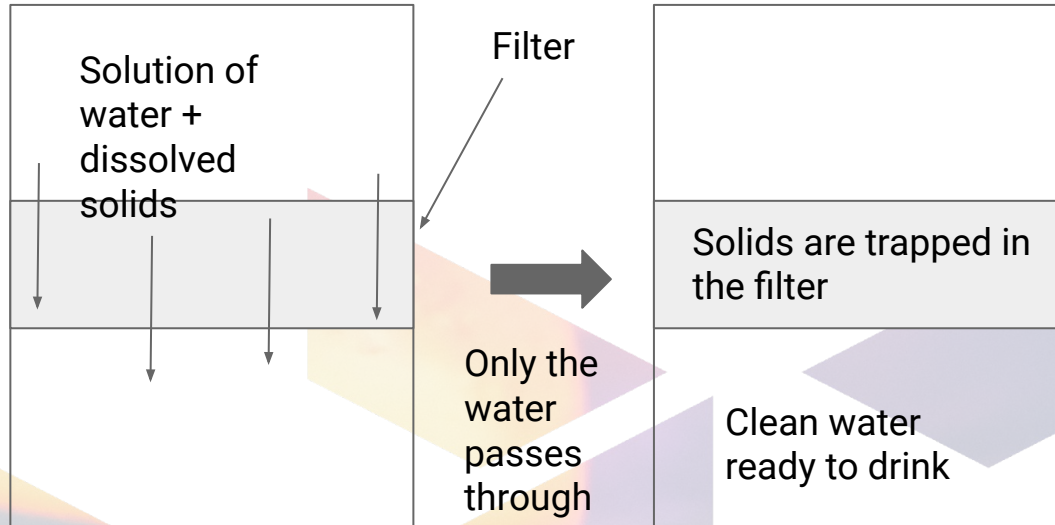
You are left with the
salt



How would we recover a liquid from a solution?

If you want to keep the liquid part of the solution but not the solid that has dissolved in it, you can use something called a **filter**.

A common type of filter that is used is a water filter. This is a special filter that only allows the water to pass through it, and traps any salts or solids that have dissolved in the water.



How would we separate materials in different states?

Separating solid and liquid

In the previous slides we discussed how to separate a solid and liquid if the solid has dissolved to form a solution. But what if the solid hasn't dissolved?

If a solid and liquid are mixed together but the solid hasn't dissolved, we call this a **mixture**. There are a few different ways to separate a mixture of solids and liquids.

Can you think of a common situation where you have a solid you want to separate from a liquid? Read on to find the answer!

How would we separate materials in different states?

Separating solids from liquids

You can use a filter to separate mixtures of solids and liquids too. For example when making coffee.



The filter paper is thin enough that the dissolved coffee in the water will pass through, but no solid coffee will.

The solid is kept in the filter and the liquid goes into the container below.

How would we separate materials in different states?

Separating solid and liquid

You can use a sieve to separate solids and liquids.

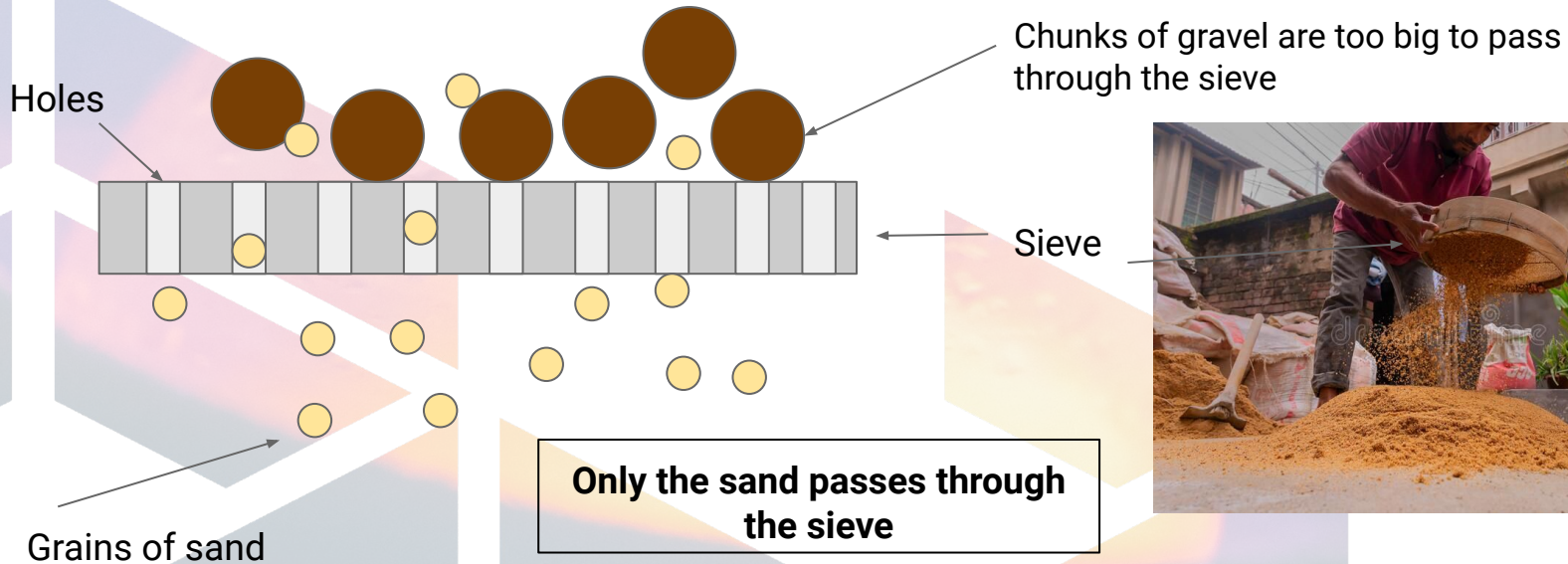
A sieve is like a filter but with much bigger holes. You may use a sieve to drain the liquid water from solid pasta, or get lumps out of custard.



How would we separate materials in different states?

Separating different solids

Sieves can also be used to separate mixtures of different solids if one solid is much bigger than the other. People use sieves to separate sand and gravel.



How would we separate materials in different states?

Separating gases

Filters again can be used in a similar way to separate different gases, or solid particles in gas. They are used in car engines to filter out some harmful substances before gas leaves the exhaust, including soot and dust.

Clean filter



Dirty filter containing dust and soot

So, what different equipment/methods can we use to separate mixtures?

Sieves



Can be used to separate:

- Mixtures of solids and solids
- Mixtures of solids and liquids

Filters



Can be used to separate:

- Mixtures of gases, and solids and gases
- Mixtures of solids and liquids
- Solutions of solids and liquids

Evaporating



Can be used to separate:

- Solutions of solids and liquids (where the solid is dissolved)

Try it at home - Dissolve it!

What do you need?

- A glass or clear container
- Cold and warm water (always ask an adult if you are using the hot tap)
- A teaspoon
- A selection of items to test. For example, we suggest sugar, salt, flour, sand, paprika, ground pepper and marmite
- A pen
- A piece of paper
- A timer (optional)



Instructions:

1. First, get your paper and pen ready to make notes. The best way to do this is to draw a table, with the names of your items down the first column and the words 'dissolves', 'does not dissolve' 'time in warm water' and 'time in cold water' along the top of the columns.
 2. Next, fill a glass with cold water.
 3. Then, take your first item and put it into the water e.g. a teaspoon of salt
 4. After that, stir it around in the glass with a teaspoon and observe carefully as you do. If your item dissolves, you will no longer be able to see it. If you're still stirring and timing after 3 minutes, you can tick that this item does not dissolve.
Top tip - if you have a timer, turn it on now and time how long it takes to dissolve.
1. Repeat this with every item you have chosen, making sure you write down your observations.
 2. Finally, repeat again but with warm water (always ask an adult if you are using the hot tap).

Try it at home - Filter it!

What do you need?

- A glass jar
- An elastic band
- A piece of cloth or fabric
- Water
- A mixing bowl or jug
- Some substances such as soil, sand, gravel, sugar etc.



Instructions:

1. First, put a piece of cloth over the top of the jar and hold in place with the elastic band
2. Next, put one of your chosen substances in a mixing bowl or jug with some water and stir around
3. Then, pour the mixture onto/through the cloth into the jar below.
4. Finally, observe how well your mixture is filtered. What is left behind? What does the water look like below in the jar?